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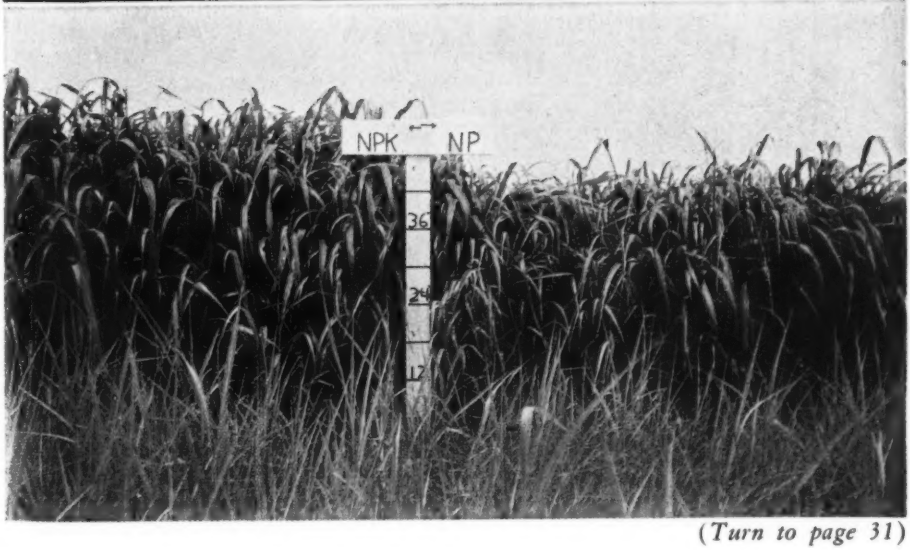

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Better Crops with PLANT FOOD

The Whole Truth—Not Selected Truth

R. H. STINCHFIELD, *Editor*

Editorial Office: 1102 16th Street, N. W., Washington 6, D. C.

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A New Use for Cotton

Better Crops with PLANT FOOD

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Vol. XL WASHINGTON, D. C., OCTOBER 1956 No. 8

Are We Through With . . .

The Windmill Era?

Jeff McDermid

(Elwood R. McIntyre)

As we think of roses in June and icicles in January, so do we find it natural to consider the power of wind when a national electoral campaign draws to a gusty end. Like Don Quixote astride his bony Rosinante, hosts of blowhards have been fighting windmills from the backs of traditional donkeys and elephants. This suggests the possibility of a brief review about the harnessing of wind which, with falling water, made up the mainstay of primitive power the world over before steam and electricity multiplied the opportunities of civilized man.

We who traveled the rural highways early in the present century recall how dotted were the countrysides with steel windmills on lofty metal towers, with stock troughs and tanks and pump jacks as regular equipment thereto. Windmills preceded the tall silos and cylindrical harvest storages now seen widely in livestock states. In many prairie states, settlers built or bought wind machines even before they moved from sodhouses into regular "upright and el" dwellings. They had to harness the same erratic force that drove rolling bunches of tumbleweed thistles or hatched up cyclonic outbreaks which chased the pioneers into convenient dug-out shelters. Sites for waterfall mills were far less available, hence our grandsires relied on the only means they had to pump and grind—the windmill and animals in treading motion.

Today you take a long drive indeed before you see the whirring fans of a busy windmill, except in the most remote sections or in the cattle and sheep ranch areas of the western foothills. But windmill history makes a

typical epic of American progress and manufacturing zeal. Few have taken the pains lately to mention it much, with our eyes cast so eagerly toward radar and atomic power. Maybe it's the right time to spill it. For ancient though the windmill is, it may come back to us to help provide greater power than ever before.

Just within the past 30 years, so authorities tell us, more than one and a half million windmill heads—wheels, gears, generators, and such upper mechanisms—were produced in this country alone. There were also 800,000 towers produced as well, so that almost 10,000 tons of steel still go into these wind-using structures.

MAN hasn't stopped seeking better methods to hitch up Pluvian power either. In the late war years a wind machine of gigantic size was erected on Grandpa's Knob in rural Vermont. It had blades that measured 175 feet from tip to tip and stood on a 120-foot tower. It generated enough electric current to supply 2,000 homes—but proved for the moment to be impractical from the cost standpoint. Since then other proposals have been drawn up for super-duper wind power apparatus. One engineered in the Federal Power Commission provided on paper for a giant affair with 200-foot wheels mounted on a tower almost as tall as the Washington monument.

Many other intricate and complex wind machines intended for electrical generation have been developed and discussed by talented men in America and abroad. These include machines invented and tested by Herman Honnef and Kleinheinz in Germany, the Enfield-Andreau 100-KW wind-driven generator in England, the John Brown machine on Costa Hill in the Orkneys, the SEAS generator in Denmark, new designs at Denmark's windmill research station at Askov, the 30-KW Lykegaard invention there, and the Russian Balaclava experimental mill.

Reference volumes on modern wind power in combination with other sources for reliable power, both direct and stored, are plentiful. Need for real international cooperation is apparent, and first steps to secure it have been taken by the Organization for European Economic Cooperation and UNESCO in planning aid to underdeveloped countries.

Recently we queried one of the nation's largest and oldest windmill manufacturing companies in Nebraska. Mr. Lindell, Sales Manager, replied that official figures for 1955 state that only 10,482 windmills were sold by all American manufacturers. Back in the early 1940's the average annual sale of windmills was between 40,000 and 50,000. Only about five major manufacturers of complete windmills are left to serve the public.

Exports take care of almost 20 per cent of the American windmill volume. If many foreign countries had dollars instead of the soft currency, the trade overseas in windmills and parts would be greater. Yet American windmills bob up in unexpected places. A desert sheik of Araby uses one to keep an oasis watered. South American ranches have them. A few have been used at sea to pump water out of barge bilges. Television antennae adorn others. Irrigated groves in Palestine use them.

IT's not so long ago that the USDA issued practical bulletins on wind-power selection and use. One such authority writing in a government circular a few years ago said: "Probably from no farm machine is so much work expected for so little attention as from a windmill. And probably no farm machine will do so much in return for a small initial investment and get so much energy from nature's store without cost to man."

Yet he warned farmers that too many of the manufacturers then failed in one particular when they overstressed the little amount of attention required to

maintain a windmill properly. The author also advised prospects to beware of manufacturers who offered extra cheap towers, for too often, he said, pot metal was put into their construction. Such towers had an inherent weakness that made them blow down in sudden squalls. He also advised that a tripod tower priced very cheap was more hazardous than the four-post tower of similar construction.

Best manufacturing skill in windmills these days points out that the proper selection of a strong tower is absolutely necessary to meet the abnormal pressure of big winds. Few if any skimp on steel for braces and girts. Too often cross braces hang loosely. Good firms now use twisted wire, cable-type braces. These adjust themselves to expansion and contraction according to the weather. By all means, substantial anchor posts and plates of angle iron steel are advocated for towers.

In those government bulletins, which date back almost 40 years, it was suggested that in choosing a windmill it was unreliable to measure the available wind power by average hourly velocity. Rather, the idea was to consider the durations—that is, the times during which the local winds reach certain hourly rates. In one standard work of that era they used the wind velocities per hour reported by the Weather Bureau at Cheyenne, Wyoming. In this table it was noted that in the April-September period the average taken per month indicated a wind flow of up to 5 miles per hour for 210 hours, from 6 to 10 miles for 283 hours, 11 to 15 miles for 142 hours, 16 to 20 miles for 62 hours, and speeds of 21 to 25 miles for only 22 hours per month.

Almost any type of windmill, even the crudest, will turn well in a high breeze, but it's the performance in a light wind that calls for very technical manufacture. There must be coordination in wheel-sail design and motor operation. To provide adequate pumping power in times of light winds, high-grade roller bearings to reduce retarding friction, with gears cut to utmost precision for smooth performance, are built into the modern mills.

ONE of the tiresome and unliked jobs of the old days was to climb up and oil the bearings and shafts of the windmill. That's a thing of the past. Nowadays the gears are fixed to dip themselves in oil, while the oil drips carry the oil up to the crossheads. Special scraping devices then shear the oil from the drips and lubricate the guide rods and bearings. After the flow to working parts is completed, a return duct carries it back to the oil reservoir—with little or no leakage loss.

Then there was the old swivel rod often used to shut off the mill's action. Many manufacturers now utilize a better device for pulling the windmill out of gear. It is made of heavy steel pipe with a plunger rod guide casting riveted on its lower end. Even a child can handle this job, because there is nothing to catch or bind.

In matters of human safety also, the record of the windmill is high. Men have had minor bruises and cuts

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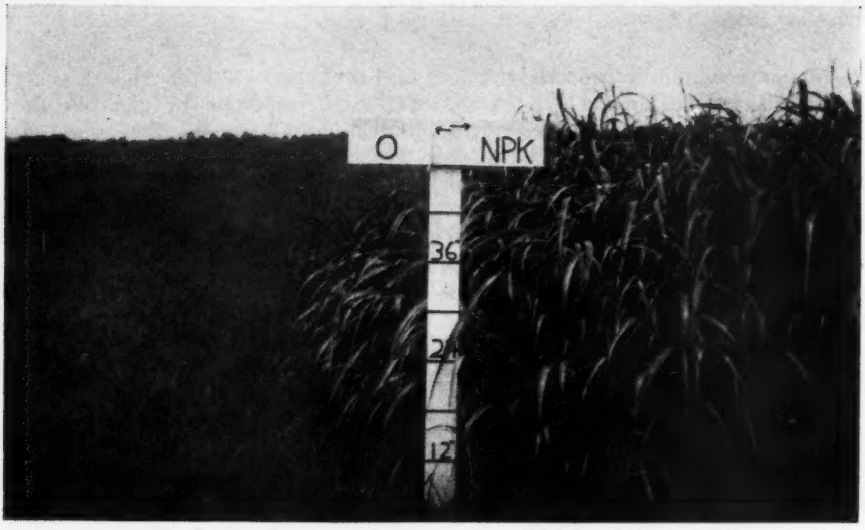

Fig. 1. Response of Johnsongrass to nitrogen, phosphorus, and potassium fertilization.

Johnsongrass a Menace True or False?

By T. C. Tucker

Agronomy Department, Mississippi State College, State College, Mississippi

FOR farmers who have it in a field of corn or cotton, Johnsongrass obviously is a menace. But what about a farmer in the Black Belt of Mississippi with hundreds of acres of Johnsongrass and limited cotton acreage? Many acres of this land were once planted to cotton. What has happened during the past century to cause a reduced cotton acreage and increased attention to livestock and pastures?

Prior to the Civil War, large plantations with slaves were common throughout the Black Belt. The situation was conducive to the production of large acreages of cotton and the Black Belt was one of the South's important cotton districts. No longer is this the case. The freeing of the slaves and the loss of the labor supply have had their effect. The loss of soil by erosion and declining soil fertility have lowered the productivity of the land. Insect pests also have taken a heavy toll. The position of the Black Belt as a cotton-producing district is one of less importance today, and more attention is being given livestock, pastures, and hay crops.

The Black Belt area in Mississippi contains approximately 1.4 million acres and is known for its gently rolling land and broad valleys. Soils of this area were formed from Selma chalk, a soft limestone, or from heavy clay over chalk. They are generally calcareous to slightly acid in reaction; however, some types are moderate to strongly

acid. The fertility level of these soils has been considered to be relatively high at least in so far as phosphorus and potassium are concerned. The nutrient content of the chalk from which most of these soils were derived was also thought to be high. In years past, fairly high cotton yields without fertilization have been reported. Many soils that are now low in fertility have been severely eroded and depleted of nutrients through many years of cropping. This may not be the only explanation for the low fertility status of all the soils. It seems likely in light of relatively recent information that the chalk was quite variable in its nutrient content. Therefore, the low fertility status of some soils may not be entirely due to erosion and crop removal losses. Crop responses to the common fertilizer elements have been observed frequently. Recently, responses to magnesium and trace elements have been obtained on some soils. More and more soil tests indicate low supplies of available phosphorus and potassium.

Johnsongrass seems to be a "natural" for shallow, eroded soils low in fertility in the Black Belt. In fact, it has spread over the entire area and is quite troublesome in some cultivated fields. Large acreages of hay are cut each year.

In the spring of 1955 a fertilizer demonstration was started in a Johnsongrass field north of West Point, Mississippi. This demonstration consisted of a small area treated with a liberal application of a complete fertilizer. The growth response was phenomenal. In order to get an idea of the type of response, another simple set of treatments was applied in early summer. The treatments and yields are given in Table I.

TABLE I.—TREATMENTS AND YIELDS OF JOHNSONGRASS ON A BROOKSVILLE CLAY SOIL.

Treatment	Dry matter, lbs./A.
O	784
N	3,129
NK	3,262
NP	5,570
NPK	8,587

Fig. 2. This picture shows the effect of potash when added with nitrogen and phosphorus. It was when phosphorus was adequate that potassium had its greatest effect.

Fig. 3. Fertilization with nitrogen and phosphorus as compared with nitrogen and potassium.

It should be mentioned that this was not an experiment but merely a test of a very preliminary nature. Nevertheless, the implications may be of considerable importance. The yields are for one cutting only. True, the interpretations and application of these data are of limited value, but some interesting questions may be raised. For instance, what is the potential of this grass for hay? Many acres of land in the area have been producing little more than a ton per year in three or four cuttings. What about the potential of Johnsongrass for silage? The green weight in this one cutting from the NPK treatment was of the order

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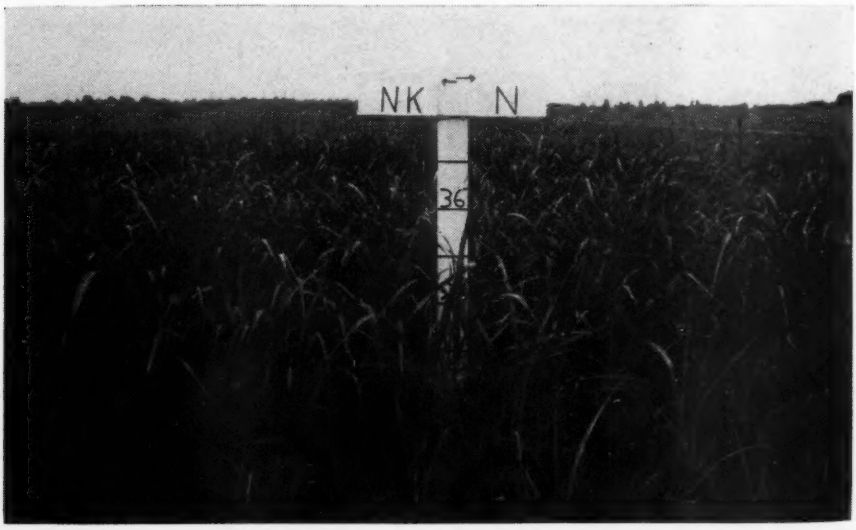

Fig. 4. Nitrogen versus nitrogen and potassium. The need for all three nutrients was indicated when any one was omitted. Without phosphorus the potassium treatment had little effect.

Potassium—The Alkali of Life[1]

A Critical Review

By Clement D. Vellaire

Kalamazoo, Michigan

DUE to the development of rapid analytical methods, the flame photometer and isotopes, a wave of renewed interest in the alkali metals in living processes has taken place. During this period many seemingly unrelated observations have been made. To collect some of these and add them to the general picture is the purpose of this presentation. Since potassium seems to be of greater importance it will receive major attention.

History

Certain potassium-containing materials were among the first fertilizers used by man. Woodash was used extensively in the American Colonies. Recognition of the importance of potassium in the plant kingdom dates from Justus von Liebig's report to the British Association for the Advancement of Science in 1840. Since that time its use as a plant food has grown until in 1950 the consumption of fertilizer potash in the United States was over a million tons. There have been extensive investigations of its value and requirements in plant nutrition, and some in plant metabolism where much work lies ahead.

Potassium acetate was introduced into medicine by Mueller in 1610 under the name Terra Foliata Tartari. About 60 years later potassium sodium tartrate was discovered by Seignette at Rochelle, France, and was known as Seignette's salts or Rochelle salts. Its manufacture was a family secret for over half a century. Later the sulfate was introduced by Glaser and others.

The first recognition of the importance of potassium in animal tissue was made by Sidney Ringer in 1883 in connection with his perfusion experiments with frog hearts. He found that it regulated while calcium strengthened the normal heart beat. Since then, many other solutions containing magnesium, phosphate, carbonate, etc. have been used by others for special purposes, both experimental and clinical.

Dietary Sources

Of first consideration is the supply in our food. In Table I are shown the concentrations of potassium in some raw and processed foods. In the fruits and grains not only is the amount of potassium high, but also the ratio to sodium is high. The plant has done so good a job of concentrating potassium to the exclusion of sodium that the herbivorous animal must search out the "salt lick" or have the salt block in the feed box.

Primitive man seems to have retained this taste for salt while shifting to an omnivorous diet. Civilized man has done even worse by making this salt pure sodium chloride and altering his staff of life, the grains, in the processes of preparation. This is noted in Table I by the differences between wheat, bran, and clear grade flour. In the wet milling of corn almost all minerals are transferred to the steep liquor, and the finished products are

[1] Presented before the Division of Fertilizer and Soil Chemistry, American Chemical Society, at Minneapolis, Minnesota, meeting, September 1955.

TABLE I.—POTASSIUM CONTENT OF FOODS

	% Na	% K	K/Na
Orange juice, fresh	0.001	3.48	3480.
Cider, fresh	0.0001	0.120	1200.
Deproteinated skim milk	0.039	0.124	3.2
Corn steep liquor	0.15	3.48	23.
Corn syrup (glucose)	None	None	.....
Corn starch	None	None	.....
Malt extract No. 1	0.05	0.29	5.8
Malt extract No. 2	0.008	0.39	48.5
Beer No. 1	0.0010	0.0340	34.
Beer No. 2	0.0050	0.0400	8.
Wine (average of 9 varieties)	0.0033	0.0890	27.
Blackstrap molasses	0.169	3.97	23.5
Purified cane sugar	None	None	.....
Sugar beet	0.007	0.201	29.
Purified beet sugar	None	None	.....
Wheat, whole grain	0.003	0.520	173.
Wheat germ	0.004	1.151	288.
Wheat bran	0.005	1.539	308.
Patent flour	0.001	0.109	109.
Clear grade flour	0.002	0.174	67.

demineralized starch, glucose, and corn oil. It is of interest that the minor elements, Fe, Cu, Co, Mn, Zn, Mo, and Mg follow this same pattern.

In vegetables and fruits there is considerable potassium, but methods of preparation and addition of modern salt reduce the potassium to sodium ratio. Meat is an excellent source which is generally over-balanced by added salt. The carnivorous animal eating the whole prey, flesh and blood, gets the necessary balance.

Mother's milk, considered ideal for growth of the infant, has the analysis shown in Table II. Even here, where nature would maintain constant composition, there seems to be a possible reflection of the mother's diet.

Like most dietary requirements, that of potassium can be divided into maintenance and growth. Working with chicks, Burns et al. (24)* have found these to be 0.25 and 0.40 per cent of the diet. The values for sodium were lower, 0.10 and 0.30 per cent. Gillis (71) previously obtained similar results with chicks and a value of 0.16 for rats. Shaw and Phillip (152) reviewed and extended these studies to other animals. A study of the interrelation of the dietary potassium and sodium was made by Meyer, et al. (120) with very interesting results. Optimum growth in rats was obtained with 0.50 per cent potassium and 0.25 per cent sodium, a ratio of two. Large varia-

* Because of the large number of literature citations, the listing will not appear in the magazine. It can be obtained in the reprint which will be available shortly after publication of the second installment of the article.

TABLE II.—COMPOSITION OF HUMAN MILK

	% Na	% K	K/Na
Holt et al. (New York City, 1915)	0.0126	0.0477	3.8
Escudero and Rothman (Buenos Aires, 1949)	0.012	0.0521	4.3
Macy (Detroit, 1949)	0.0172	0.0512	3.0

tions of either element in either direction were less effective. Deaths occurred in the low potassium diets with increasing frequency as the sodium was increased. They did not occur on the high potassium regardless of the sodium. Miller (122) has done similar work and points out that after a time on low potassium diets, animals fail to respond to its addition.

Such studies are not possible in man but, as frequently happens, a pathological situation gives considerable information. Hereditary periodic paralysis, a weakness developing in susceptible persons when sufficient potassium does not accompany food, is such a condition. Ziegler and McQuarrie (175) found that the carbohydrate to potassium ratio must be under 75 to prevent attacks. This ratio for cow's milk is 36 and can be increased to 60 without provoking them. They develop after eating sugar, starch, or fat and can be controlled by dietary restriction or by the addition of potassium. Sodium is not involved in this condition.

The need of potassium for growth has been shown by Miller (124) who demonstrated retarded growth by its lack, but found no ill effects when the potassium to sodium was 14 or over. He mentioned abnormal physiological changes that become apparent only at a later stage of development. Cannon and coworkers (26), Frost and Sandy (65), and Frost and Smith (66) have shown that protein or amino acid mixtures are not utilized unless accompanied by a critical amount of potassium. This holds for growth of the young and replacement following depletion. This is true for both oral and intravenous administration. Other minerals, including calcium, magnesium, iron, copper, etc. are also required (118).

Another special period of growth, pregnancy, increases the potassium requirement. Certain disorders may result when this high demand is not met. These will be considered in a later section.

The physiological actions of sodium and potassium resulting from the simple ions are: maintaining osmotic pressure, balancing with other ions to maintain the correct body acidity, and altering the solubility of certain body materials such as peptides and proteins. These they have in common, but beyond these potassium takes an active part in many energy transfer reactions in the body.

Potassium Is Intracellular

The first difference noted is in the concentration inside and outside of all cells, sodium being predominantly extracellular while potassium is intracellular. Elkington, et al. (46) studied this and concluded that a part of the intracellular base was osmotically inactive and that its amount could vary rapidly. Iseri (88) considers this same factor in the base uptake of cells during recovery. Here it might be recovery from any stress, injury, disease, or plain exhaustion from normal activity.

A study of exchangeable potassium by the isotope dilution method reported by Corsa (34) showed a part rapidly exchangeable, with the remainder being relatively stable. That in the red blood cells and brain was the most stable, while that of muscle was a little less so. The Harvard workers (89, 124, 170) have recently adapted this method to the simultaneous study of sodium and potassium. They applied it to the body as a whole to supplement balance studies. Harris (80) studied the exchange rate for frog muscle at reduced temperatures and found only a fourth rapidly exchanged. At 0°C the whole process was slower and the last fifth exchanged very slowly.

The effect of potassium on tissue metabolism *in vitro* has been studied by a number of workers; in liver slices (55, 161), in brain (93, 105, 116. 128), and in kidney slices (41, 126). In these we note an optimum concen-

tration of potassium for any set of conditions. It must be a part of many high energy compounds, particularly the high energy phosphates. Lardy (99) gives some of its relations to phosphorylation and fatty acid oxidation. Christensen and Hastings (30) studied its combinations with the phosphotides, cephalin and lecithin. And Melchior (117) gives us the data on the complexes with adenosine triphosphate.

Potassium Activates Enzymes

Many enzymes require potassium for activation: salivary amylase (146), adenylic phosphorylase (22), cholinesterase (75), pyruvic phosphoferase (91), acetate-activating enzyme (165), phosphotransacetylase (157), carbonic anhydrase (15), and possibly many others. There is a close connection with thiamine, and many of the symptoms of beri-beri are due to a lack of potassium (131). This may be coincidental, both due to the poor diet.

Some of the relations to sodium and phosphorus have already been presented. Ringer's early work clarified the interaction with calcium in heart action. Engel, et al. (51) have extended it to general tetany and have shown the potassium to calcium ratio to be of utmost importance. Some insight into this interrelationship is given by Erdös and Snellman (52). They showed the electric charge on myosin, the active protein of muscle, to be dependent on the potassium to calcium ratio. There was no charge at body acidity when the ratio was one. This balance with calcium explains the lack of symptoms in certain cases of extremely high or low plasma potassium concentrations (171). The interrelations of magnesium with potassium have been studied by Smith (154). There is antagonism in some respects but not all. The subject deserves further study.

With the actions just pointed out, many interrelations with the endocrine system are to be expected. Any growth-promoting secretion such as that of the hypophysis (158, 168) and testes (56) causes retention of tissue-building materials, nitrogen, sodium, potassium, etc. Over-activity of the thyroid or parathyroid (20) is associated with a loss of potassium from the body and is considered the immediate cause of most of the symptoms. Epinephrine causes a release of potassium from the lung (81) and from the liver (43). But it also protects against a fatal excess in the plasma following adrenalectomy (44).

In the extensive literature on the adrenal steroid hormones are many references to potassium correcting many of their undesirable effects. Bacchus (6) reports that it corrects the DCA-induced cardiorenal hypertrophy. Glafkides, et al. (72) and Kinsell, et al. (94) report protection against the diabetic action of ACTH and cortisone. The potassium changes in Addison's Disease have been studied by Goodof and Bryde (73), and by Marks and Feit (111). Kjerulf-Jensen, et al. (95) report a case of simple potassium deficiency wrongly diagnosed as Addison's Disease. In this disease there is gradual destruction of the adrenal cortex resulting in asthenia, emaciation, low blood pressure, pigmentation of the skin, hypoglycemia, and loss of sodium. Part of these symptoms are the result of the shift of potassium from the cells to the plasma, a result of interferences with cellular metabolism. The patient was later maintained in health by oral potassium phosphate. Cushing's Syndrome (hyperadrenalism) (155) also shows unbalanced electrolytes. Bennett and coworkers (13, 104, 167) have shown that potassium administration counteracts the catabolic and salt (sodium) retaining actions of ACTH, and have suggested its routine use. Since potassium is the more directly involved in life processes, a better point of view on this action would be "potassium releasing" rather than the current "sodium retaining."

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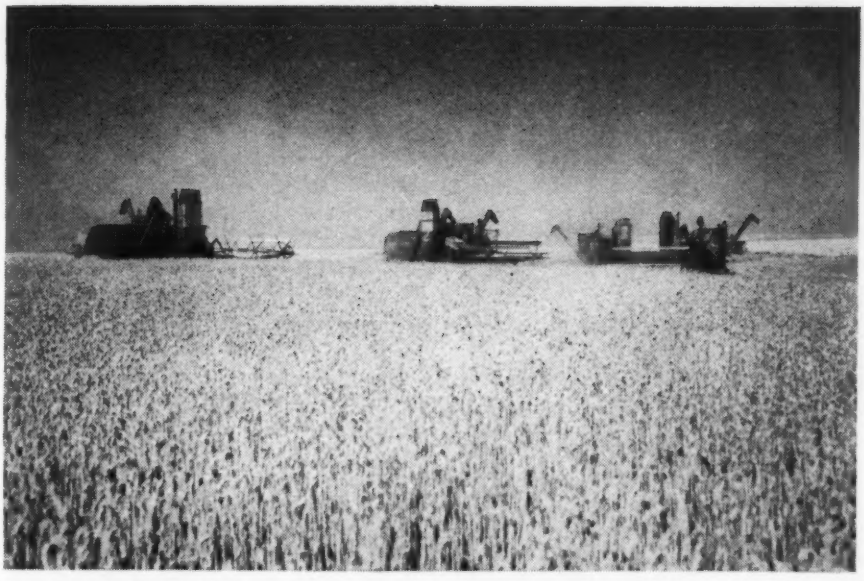

Fig. 1. A wheat yield of 30 bushels grain and 1¼ tons straw remove 40 lbs. N, 20 lbs. P_2O_5, and 30 lbs. K_2O.

Withdrawals from the Soil Bank — Pacific Northwest Crops —

By Grant Braun

Portland, Oregon

As soon as a seedling starts growing and developing a root system, it begins to draw upon the store of plant nutrients in the soil. The mineral nutrients which are obtained from the soil comprise on an average only about 5% of the total dry weight of the plant; however, though small in amount, these nutrients are vital to its normal development. A serious shortage of any one of the essential mineral plant nutrients means a "sick" plant.

Many soils, even in their uncropped, virgin state, do not have a sufficient amount of some plant nutrients to support satisfactory plant growth. Other soils have been well supplied with the plant nutrients naturally and support luxuriant plant growth.

The forces working to deplete our soils of essential nutrients are:

Wind and water erosion—which transports the topsoil and the plant nutrients in it to places where it is much less useful and largely lost for present agricultural purposes;

Leaching—whereby the excess water in the soil carries out the plant nutrients in drainage water or carries them to a depth in the soil beyond the reach of plant roots;

Crop removal—whereby the constant growing of crops and the removal of at least part of them take plant nutrients

Fig. 2. Onions (30,000 lbs. of bulbs) remove 81 lbs. N, 39 lbs. P_2O_5, and 75 lbs. K_2O.

from the soil each year at a faster rate than the soil can be naturally replenished.

The forces we use to resist soil depletion and to rebuild our soils are:

Good cropping systems, good soil management, and good water management;

Replenishment of plant nutrients in the soil through the use of manures and fertilizers.

The large amount of plant nutrients

Fig. 3. Four tons of blackberries, plus one ton of leaves, and five tons of new wood remove 93 lbs. N, 23 lbs. P_2O_5, and 58 lbs. K_2O.

removed from the "soil bank" by crops grown in the Pacific Northwest is one of the reasons we are using commercial fertilizers today. Crop removal can become a serious factor in soil depletion. Return of crop residues, soil erosion, and the "strength" of the soil, measured by its original fertility and its power to resupply nutrients each year, will determine the fertilizer program to follow.

Crop residues, such as straw, stalks, and prunings, should always be returned to the soil to slow down soil depletion, unless there is some good reason to dispose of them otherwise.

A system in which an alfalfa crop is all sold off the land is much more soil-depleting than feeding a large part to livestock on the farm, so that there will be a partial return of nutrients to the soil in the form of manure.

There are some misconceptions about the effect certain crops and cropping systems have on the fertility of the soil. We often hear that a grain crop is hard on the land, that legumes like alfalfa are good for the land, and that pasturing "rests" a piece of land.

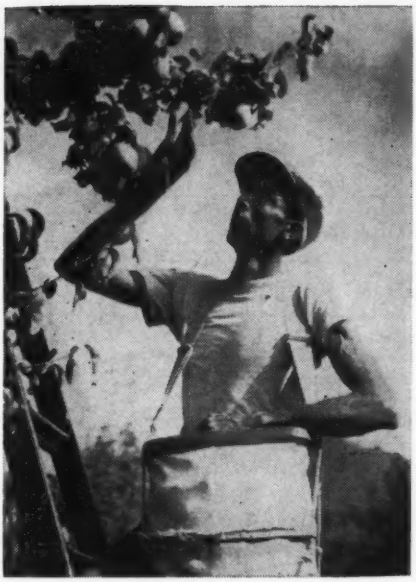

Fig. 4. A crop of 500 packed boxes of apples and 1,500 lbs. of leaves use 44 lbs. N, 10 lbs. P_2O_5, and 46 lbs. K_2O.

Grain crops may have received their reputation because continuous production of grain crops without returning crop residues or controlling erosion has

Fig. 5. A celery harvest of 350 crates (90 lbs. each) will remove 80 lbs. N, 65 lbs. P_2O_5, and 235 lbs. K_2O.

TABLE I.—AMOUNTS OF NUTRIENTS USED BY CROPS GROWN IN THE PACIFIC NORTHWEST

Crop	Part	Yield per acre	Pounds Removed					
			N	P_2O_5	K_2O	C_aO	S	MgO
FORAGE CROPS								
Alfalfa	hay	4 tons	196	40	186	207	19	49
Clover (red)	hay	2 tons	80	20	70	79	9	18
Orchardgrass	hay	3,000 lbs.	39	12	56			
Ryegrass	hay	2 tons	44	22	48			
Vetch	hay	4,000 lbs.	112	30	92			
VEGETABLE CROPS								
Cabbage	heads	15 tons	100	25	100	16	24	6
Carrots	roots	15 tons	69	39	159			
	tops	5 tons	51	21	37			
Cauliflower	heads	8 tons	45	16	53			
	leaves	6 tons	42	12	56			
Corn (sweet)	ears	10,000 lbs.	45	20	30			
	dry stalks	8,000 lbs.	76	24	110			
Cucumber	fruits	10 tons	32	24	48			
Lettuce	heads	20,000 lbs.	50	16	80			
Onions	bulbs	30,000 lbs.	81	39	75	23	45	19
Peas (canning)	green peas	2,000 lbs.	23	6	9			
	green pods	4,000 lbs.	10	2	8			
	green vines	4,000 lbs.	20	7.2	22.4			
Potatoes	tubers	400 bu.	86	32	153	7	9	16
	tops	4 tons	39.2	4.8	5.6			
Rhubarb	stems	10 tons	20	8	70			
Spinach	stem & leaves	14,000 lbs.	70	21	35	17	6	11
String	green pods	6 tons	30	9.6	36			
	leaves & stalks	6,000 lbs.	27	6	31.6			

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WHITE CLOVER YEARS
In Cycles of Soil Changes

By Wm. A. Albrecht

Department of Soils, University of Missouri, Columbia, Missouri

WHY we don't have a good crop of white clover and the fine honey from it every year, or why this kind of clover comes seemingly in cycles of about the biblical seven years, are not new queries. The beliefs they imply have been more than just fancy in the minds of older observers of the volunteer white clover coming into the bluegrass pastures and lawns in periodic years. The inquirers have connected the intermittent appearance of white clover with certain kinds of soils. They have emphasized this cycle of dominance by this kind of clover especially on the glaciated, the windblown, and on the other more fertile soils where the growths of the bluegrass are also good. Some have believed that the "white clover year" is the "normal" one after a year or two of drought.

That we may expect white clover prominence in cycles of years is the suggestion from some soils studies in Missouri. Those studies suggest that this crop's periodic prevalence is related to the increasing degree of the soil's saturation by exchangeable calcium which favors the nutrition, and thereby the appearance and growth, of such a legume. So, theoretically then, we may well look to cycles of increase and de-

Fig. 1. White clover is a "periodic" legume in the bluegrass lawn only in certain spring seasons.

pletion of exchangeable calcium as possibly the cause of the white clover cycles. We may well expect this where the soil contains a reserve of weatherable calcium-bearing minerals in the surface or subsoil, as the glacier, for example, might have left it. Also, it would seem reasonable where unweathered floodplain deposits of silt, brought in from the arid West by the Missouri River for example, are constantly blowing from there and renewing the surface soil by these calcareous deposits on the soils of north Missouri. Then, too, when the clay of the soil, resulting from the weathering of the original minerals, is a partially reversible colloid which adsorbs the active fertility elements while moist (but may not take them up again when wetted after it lost them through severe drying), the very prominent white clover of the 1956 spring makes us give consideration to the suggestive data from some soil studies under continuous bluegrass sod.

Based on Soil Samples

Apropos of the belief that the "white clover year" is a sequel to one of drought, the studies included soil samples collected annually from 1931 to 1938 inclusive, the last of which was considered a "white clover year." The plots went out of cultivation and into the blue grass sod in 1930. While the 50-year average of the annual rainfall was 34.44 inches at Bethany, Missouri, the site of the Soil Conservation Research Station where the soils were studied, it was but 24.43 and 21.80 inches for the two years, 1936 and 1937 respectively, preceding the clover prominence. The former of these is well remembered for its disastrous heat and drought during June, July, and August. Also in 1934, there had been an almost equally serious drought. During the first half of the year 1938, the total rainfall was 16.06 inches with the amounts of 2.50, 4.39, and 3.07 inches for the months of April, May, and June respectively, to invite the white clover in what would seem nearly normal precipitation.

Starting with 1931, the soil samples were taken annually in a series of plots. But particular study was made of the changes in the soil under continuous bluegrass sod. This was given no soil treatment. It had no crops removed and was showing no more erosion than what would amount to carrying the surface seven inches of soil away in 4,545 years. The soil changes suggest themselves as theoretical reasons for the cycles of periodic prominence of white clover in continuous bluegrass. They suggest corresponding cycles of fluctuating growths in the sod crop too. These would go unnoticed since they do not call themselves to our attention by such flash of color as does the white clover.

The soil under sod was examined carefully by one-inch layers in order to measure the changes with time more accurately. This plot served as the basis for measuring the changes in the other plots undergoing fertility treatments, and surface soil losses. It was the check for the rates at which the other plot profiles were being truncated or whittled off at their tops. The sod plot was "the standard" in the study.

Soil samples for the alternate years 1931, 1933, 1935, and 1937 were considered sufficient numbers to show the changes in the soil fertility. Since legumes like white clover require calcium (and magnesium) generously, it is significant to note the increase in the exchangeable calcium during those seven years before the one of white clover prominence. For these four odd-numbered years the percentages saturation by calcium of the soil's exchange capacity stepped up in the following order, 56.96, 55.09, 69.70, and 70.96, respectively. Since for better crops of legumes, like alfalfa, the experiences with soil tests correlated with the crops suggested that the calcium saturation should be brought up to 75%, it seems highly probable that this increase in the soil's saturation by this dibasic nutrient

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Fertilizer and the Florida Farmer

By William L. Pritchett

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FLORIDA'S sandy soils are sometimes held in ridicule by her northern friends possessing soils of considerable heavier texture and larger plant-food reserve. While it is true that the mineral soils of Florida are inherently infertile in their native state, they are nevertheless highly productive when properly managed. Because of the low plant-food reserve of their soils, Florida farmers have long realized the importance of adequate fertilization in a good soil management program. Through continued marked increase in the use of both fertilizer and liming materials, Florida farmers in general enjoy a relatively high farm income which certainly reemphasizes the fact that tillers of soils of low native fertility need no longer be held down to a standard of living based on nutrient delivery of low producing fields.

To accomplish these production feats, the Florida farmer applies the largest per-acre rates of fertilizer in the United States. His average annual application of commercial fertilizers to cultivated land was reported to have been 1,440 pounds in 1953.([1]) This was more than twice the average applications made by farmers in New Jersey, Rhode Island, and North Carolina, who ranked second, third, and fourth, respectively, in per-acre application of fertilizer, and many times the rates used by farmers in most other states.

Total Consumption

The 1,800,000 acres of cropland in Florida is a relatively small area compared, for example, to the 22,000,000 acres in Iowa; nevertheless, the large acreage of heavily fertilized vegetables and citrus crops results in a high annual total fertilizer consumption as well as a high average per-acre application. Total use of commercial fertilizers in the State, excluding lime and other soil amendments, is reported ([2]) at approximately 1¼ million tons per year. The annual sales of fertilizer during the past 30 years are shown in Figure 1.

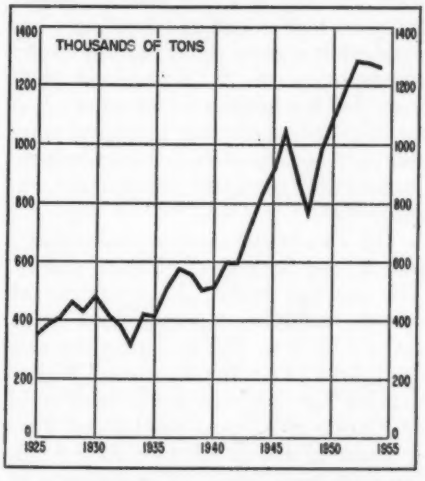

Fig. 1. Fertilizer consumption in Florida. (Agricultural Census-U. S. Bureau of Census)

Doubtless, the general increase in fertilizer consumption by Florida farmers is a reflection of the advance in research information on the value of proper fertilization practices. Nevertheless, the relationship between fertilizer consumption and general economic condition or farm income is very apparent. Note that the upward trend in consumption during this period of prosperity has been broken only during three definite periods since 1925. These drops in fertilizer sales are closely re-

lated to the low farm income during the depression of 1930-33 and the mild recessions in 1939-40 and 1947-48. That a future marked decline in agricultural income will be accompanied by a similar decrease in fertilizer use can hardly be denied, unless a definite educational program is undertaken by agricultural leaders to explain the important role of proper fertilization in cutting production costs.

N-P_2O_5-K_2O in Mixed Fertilizers

The total consumption of nitrogen, phosphorus, and potassium closely parallels that of total fertilizer usage, as would be expected; however, significant shifts in the demands for these three plant nutrients in recent years may be noted in Figure 2. While the popularity of higher analysis fertilizers has resulted in a more rapid increase in the consumption of N, P_2O_5, and K_2O than that for fertilizers as a whole, it is interesting to note that in recent years this increase has been due primarily to increases in nitrogen and potash consumption.

The plant-food content of fertilizers sold in the State has increased slowly. The average N-P_2O_5-K_2O content of mixed fertilizers has increased from about 17.1% to 22.2% during the past 10 years. The trend toward higher analysis fertilizers has not been as rapid in Florida as in most other areas. This is probably due to the continued popularity of low-analysis organic sources of nitrogen for sandy soils, to the proximity of phosphorus sources, and the low content of sulfur in Florida soils which has encouraged the use of common superphosphate in compounding fertilizer mixtures.

The continual use of high rates of complete fertilizers on vegetable and fruit crops has resulted in an accumulation of phosphorus in the soil. As a result, it has become a practice to reduce or completely eliminate this plant food from the fertilizer program for these crops after several years of fertilization. Since these crops account for a large percentage of the total consumption of fertilizers in the State (80% of the mixed fertilizers and 86% of fertilizer materials sold in Florida during the last fiscal year were sold in the central and southern sections where these crops are grown) a leveling off in sales of phosphorus might be expected (Fig. 2).

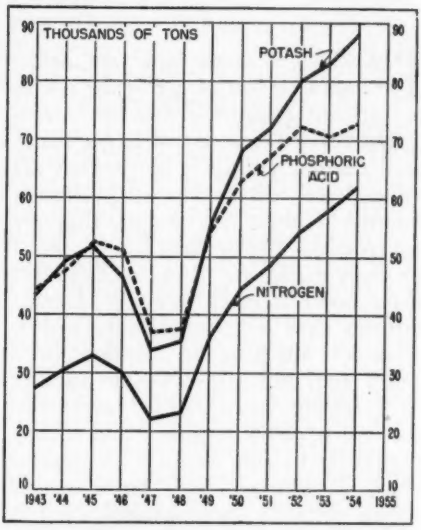

Fig. 2. Consumption of N, P_2O_5, and K_2O in mixed fertilizers in Florida. (Fertilizer Consumption Summary Report—Florida State Department of Agriculture)

On the other hand, there is little tendency for the more mobile nutrients, nitrogen and potash, to accumulate in sandy soils. As a matter of fact, these two plant foods are used in relatively large amounts by most growing plants and are seldom applied in excess.

Florida's mineral soils are uniformly low in nitrogen and potassium and the use of these fertilizer materials has closely followed the agricultural development in the State. There has been a particularly marked increase in the use of potassium and in the ratio of K_2O to N and P_2O_5 in mixed fertilizers.

Fertilizer Materials

In 1954-55 approximately 15,000 tons of nitrogen, or 25% of all the nitrogen used in Florida, were sold as materials

for direct applications. Ten years ago the approximately 4,000 tons of nitrogen sold as materials represented only about 14% of the total. This rise probably reflects an increased interest in topdressing with soluble nitrogen sources made available largely since World War II. Sales of ammonium nitrate, calcium nitrate, and ammonium nitrate-lime mixtures have risen rapidly since 1938-39. Sodium nitrate has maintained its supremacy in total tonnage of materials; however, in terms of nitrogen, ammonium nitrate is in first position followed by sodium nitrate, calcium nitrate, sodium-potassium nitrate, and urea.

The sales of phosphorus materials for direct application have generally decreased in recent years. The use of concentrated superphosphate in Florida, while never great, is no longer reported.([3]). Sales of both superphosphate and basic slag have declined since 1950 and only the consumption of raw phosphates continues to show a general increase.

With the exception of sodium-potassium nitrate, the sale of potash materials has shown no marked change since 1938-39. The sales of certain potash materials, as well as nitrogen materials, are closely related to their availability on the market. However, an interest in the use of potassium, as well as nitrogen, for topdressing certain crops probably has contributed to the substantial increase in sales of materials containing both of these plant foods in the last five years.

Agricultural limestone sales have increased 1,800% during the past 16 years, as shown in Fig. 3. This increase in consumption of high calcic and dolomitic limestones (not including hydrated lime and gypsum) from 25,000 tons in 1939 to 450,900 tons in 1955 is doubtless a result of (a) research findings on the importance of calcium and magnesium as a plant food as well as a need for improving soil reaction (pH) for good crop production on many soils, and (b) the expanded

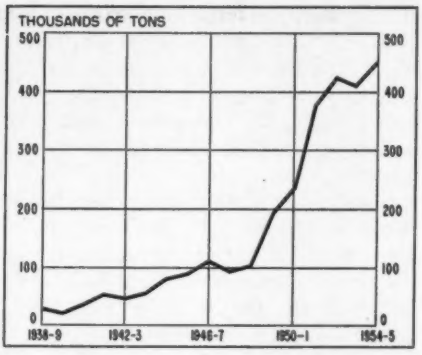

Fig. 3. Consumption of agricultural limestone in Florida, 1938-1955. (Fertilizer Consumption Summary Report—Florida State Department of Agriculture)

acreage of legume-grass pastures in recent years. However, on the basis of summaries of soil-test results during the past 10 years, it has been estimated that the use of more than three times the present annual rate of limestone would be needed to maintain cultivated and improved pasture soils in Florida at a desirable pH level for maximum production. Some 40% of the samples received by the soil testing laboratory during this period tested pH 5.5 or below, and 76% tested pH 6.0 or less.

Grades and Ratios

The total number of grades* of mixed fertilizers sold in Florida continues to increase. Since World War II the number has risen from 185 to 851. Since many growers demand special mixes, there are large numbers of grades sold in the State that are practically identical in plant food. For example, last year there were 26 grades sold in quantities exceeding 400 tons each, all of which were classified as having a 1:1:1 ratio. Large numbers of grades were sold in each of the following ratios: 1:0:1, 1:1:2, 1:2:1, 1:2:2, and 2:1:2. This large number of grades takes on added significance when one considers that all experiment

*Grade, as defined in Florida Commercial Fertilizer Law, "means the minimum percentage of total nitrogen, available phosphoric acid, and water-soluble potash stated in the order given—."

station fertilizer recommendations can be met with about 25 grades representing 15 ratios. It is estimated that, if necessary, this number of grades and ratios could be reduced to about 11 without undue inconvenience to any grower.

That many of the grades are special mixes and handled in small lots can be seen from the fact that one quarter of the grades accounted for more than 96% of all fertilizers sold. About three fourths of the fertilizer was mixed in only 34 grades and one half of all sales was of the top 11 grades.

Trends in Consumption

Although Florida farmers already rely heavily on fertilizers in crop production, the possibilities for increased fertilizer consumption appear rather favorable. An increased effort should be made to educate the consumer of the value of proper fertilization as a means of relieving the cost-price squeeze.

It is doubtful that yields of horticultural crops and tobacco can be substantially increased through the use of larger per-acre applications of commercial fertilizers, since these heavily fertilized crops usually receive more plant food than is removed in the harvest. Nevertheless, increased acreage of certain of these crops, greater use of supplemental irrigation practices, and adoption of better nutritional balance as a result of research and improved soil-testing facilities should result in increased crop yields as well as increased total fertilizer consumption.

The greatest advances in agricultural production through better fertilization practices will doubtless be in field crop and pasture production. There are many acres of corn and other field crops produced in north Florida without the use of a pound of fertilizer. Many other acres receive inadequate rates for economic production. This in large part explains the low average yield of 16.5 bushels per acre from the 600,000 acres of corn in 1953. It is estimated that these yields could be increased on the average about threefold by following experiment station recommendations. This would mean a fourfold increase in fertilizer application on corn. Furthermore, if all farmers followed experiment station fertilizer recommendations, there would be a twofold increase in the application to cotton, a sixfold increase to small grain, and a fivefold increase to improved pasture without an increase in the acreage devoted to these crops.

While it is obvious that Florida farmers are using insufficient fertilizers for the most economic yields of field crops, it is not simply a question of increasing the rates of fertilization to secure higher yields of these crops. In the production of field crops, as with the heavier fertilized horticultural crops, time of application, placement, and more particularly nutrient balance are important factors in securing better yields through fertilization. All of the major plant nutrients are deficient in most Florida soils and some of the secondary and minor elements are low in certain soil areas; however, as elsewhere a great variation in the level of these plant nutrients exists from one area to the next.

Nitrogen is the plant food most generally limiting in Florida soils. With the exception of peats and mucks, all soils need some supplemental source of nitrogen for maximum plant growth. The subtropical climate is not only ideal for the destruction of nitrogen reserves in the form of organic matter, but the sandy nature of most Florida soils offers a poor storehouse for the mineralized form. Approximately 85% of the 125 million pounds of nitrogen sold in mixed fertilizers during 1954-55 was used on fruits, vegetables, potatoes, and tobacco. There probably will be little increase in the consumption of nitrogen on these crops; however, the approximately 18 million pounds of nitrogen applied to field crops and pastures will have to be increased to about 90

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Fig. 1. Effects of fertilization on the growth of alfalfa. The area to the left received no fertilizer; that to the right a liberal application of a complete fertilizer.

Demonstrating Alfalfa Rules

By Webster Pendergrass and J. R. Turner

Agronomist, Tennessee Agricultural Extension Service, Knoxville, Tennessee, and Agronomist, Pacific Coast Borax Company, Knoxville, Tennessee, respectively

THE dawning of a new day in alfalfa production in Tennessee began in the 1930's but the sunny skies that followed soon began to darken and in the late 1940's it appeared the eclipse of poor production practices might actually turn the bright day of increased acreage into complete darkness. The darkest period occurred in 1952 when the alfalfa acreage dropped to little more than half that of 1949. However, the darkness began to subside a year later with the introduction of improved production practices through a series of demonstrations conducted in the major alfalfa-producing areas of the State.

The demonstrations were established to show the importance of a production program involving the application of all proven practices, but they emphasized one of the practices that had been disregarded to an appreciable extent—a balanced program of fertilization. Tennessee farmers were well aware of the importance of lime and phosphate in alfalfa production but had given little attention to the crop's needs for potassium and boron. Since the demonstrations placed special emphasis on the addition of adequate amounts of these nutrients, they have frequently been referred to as "Alfalfa Fertilization Demonstrations."

The first demonstrations were established in 1952 in the major alfalfa-producing counties. They involved the

Fig. 2. Annual topdressing with fertilizer is important in stand maintenance.

application of 300 to 400 pounds of 60% muriate of potash and 20 pounds of fertilizer borate per acre applied to established stands prior to the start of growth in the spring or immediately after the first cutting. Additional phosphate and lime were added if soil tests indicated a need for them. Representative areas were selected for treatment with small strips left on each side of the treated plot to serve as a check. On many fields the untreated area repre-

Fig. 3. Observing an alfalfa demonstration during a field meeting.

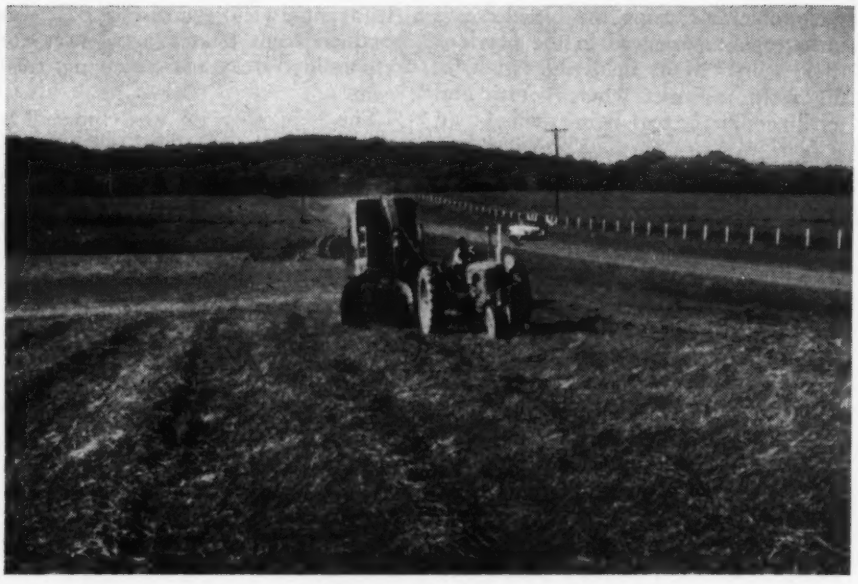

Fig. 4. Alfalfa is a valuable source of silage.

sented the farmers' normal fertilization practices.

In 1952, demonstrations were established on 110 farms in 57 counties. No yield data were taken that year, but favorable results were sufficiently evident to justify a study of selected fields across the State. A tour served as the occasion for an evaluation of the demonstrations and indicated that a program of fertilization involving all needed nutrients was the solution to some of

Fig. 5. Good growth of corn and tobacco followed adequately fertilized alfalfa.

the problems causing the big decrease in acreage experienced in the previous three years. Many fields showed striking yield increases where potash and fertilizer borate had been applied. In a few instances a thickening of the stand was apparent.

In 1953, the program was reviewed; a few of the old demonstrations were discontinued and some additional ones added. A total of 75 demonstrations were conducted for the year with more than half the treated plots being the same ones fertilized in 1952. Yield data were collected on approximately half the plots by the farmer and the county agent. The treated plots produced 27% more hay than the adjacent untreated areas. Observations indicated additional favorable results in terms of more rapid recovery after cutting, a thicker stand, healthier appearing plants, and higher quality forage.

Conducted Tour

Recorded results from the demonstrations were sufficiently extensive and visible results so apparent that a tour was conducted during the summer of 1953 to show agricultural workers, farmers, and interested non-farm groups that the shadows which had threatened to turn a new day of alfalfa production into darkness were beginning to subside. Some farmers had already learned enough from the demonstrations and their own experience to cause them to reverse their thinking and again look in the direction of increased alfalfa acreage. The tour appeared to further assure them of the possibilities of the crop when best production practices were applied.

The demonstration program for 1954 was essentially a replica of that conducted in 1953. A few of the old demonstrations were discontinued and some additional ones established in problem areas. A total of 85 farmers participated in the program with over half of them being cooperators in previous years. Again yield data were taken on a large portion of the fields. An average yield increase of 37% was obtained from treated areas over corresponding areas not receiving treatment.

The 1954 program was climaxed by a series of field meetings of farmers, agricultural workers, and interested non-farm representatives. A single demonstration served as the focal point for the meeting. The initial phase of the meeting consisted of an examination of the field and a discussion of the results obtained. This was followed by an assembly of the crowd at a prearranged spot at which time other demonstrators presented reports on their projects. In addition, detailed presentations were given by extension, research, and commercial agronomists on alfalfa production practices and the importance of carrying out each of them with immaculate care.

By 1955, the program had progressed to the point that a decrease in the number of demonstrations appeared to be feasible. Accordingly the entire list of cooperators was reviewed and those who appeared to show a real interest in the program were continued. To round out the program, a few new ones were added in sections that had not previously conducted demonstrations. The 62 farmer cooperators did a good job of carrying on the work from the time of initiation until results were measured and recorded. Again more than half of the plots were old ones, some being those selected in 1952. Yield increases were even greater in 1955 with the treated plots producing an average of 52% more forage than those receiving no treatment. The gradual increase in yield differential from 1953 through 1955 can, in a large measure, be explained by the thinning out of the stand on the untreated area of those fields included each of the three years.

The field meetings of 1954 proved to be so successful that a second series was conducted in 1955 in sections of the State not previously served. The

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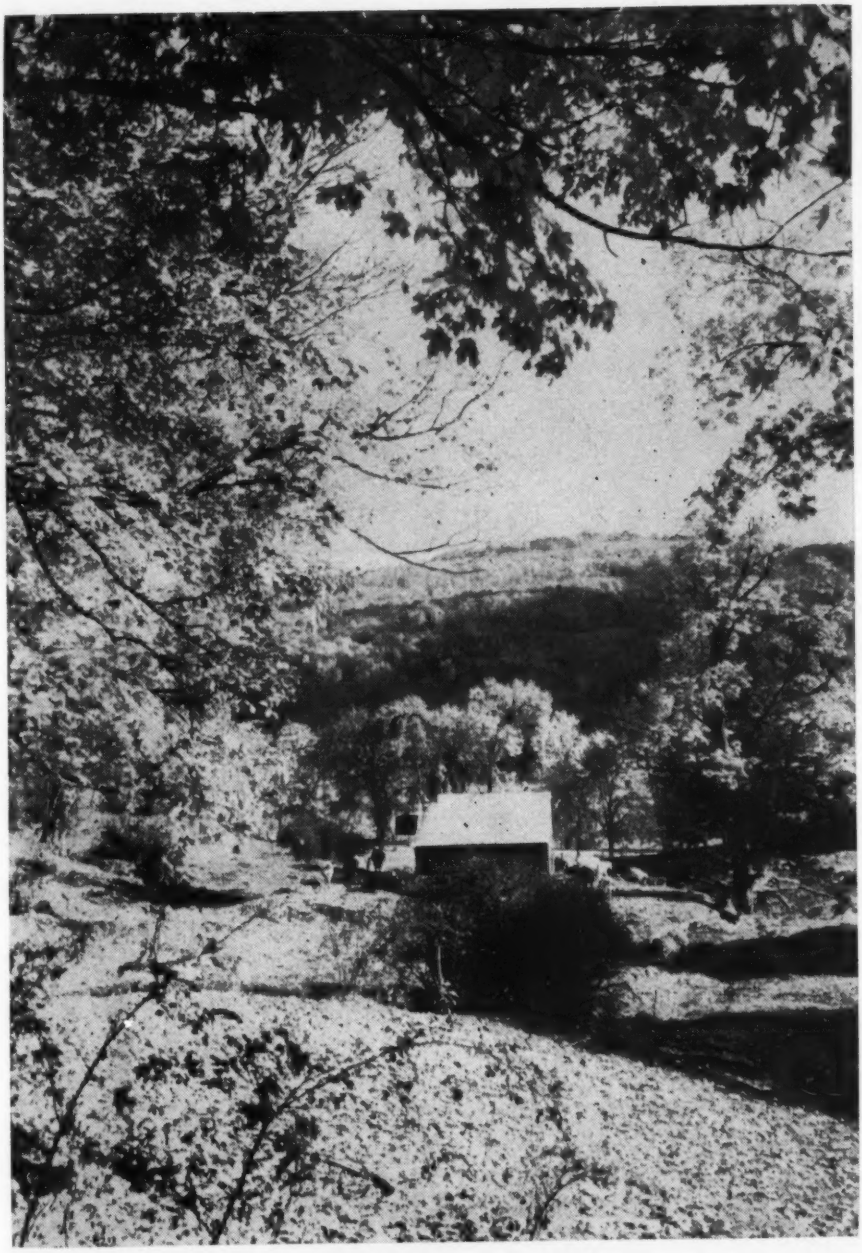
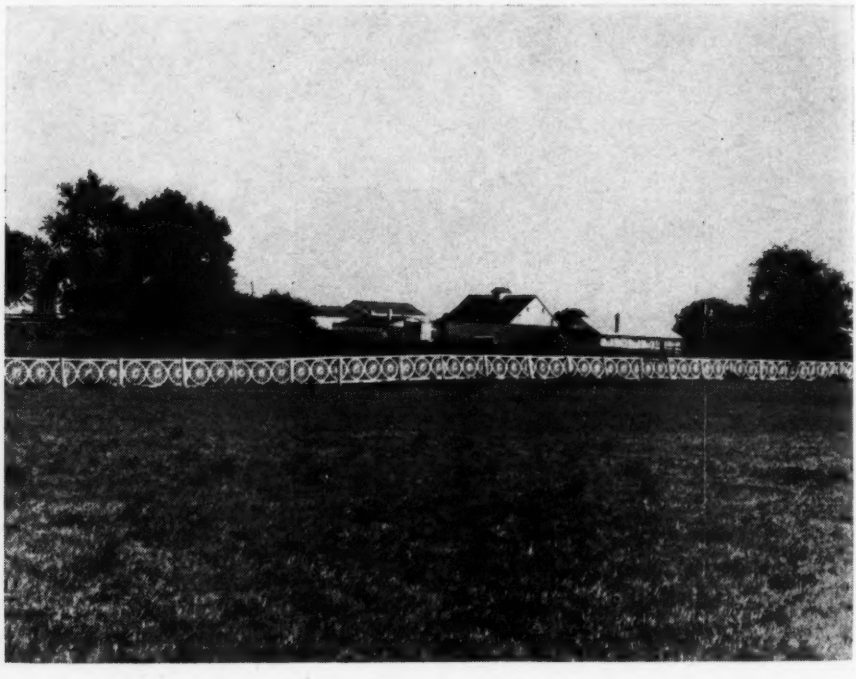
PICTORIAL



October in the Country

Above: Late fall plowing.

Below: White wheel fence.



Above: One-man ferryboat.

Below: Follow the leader.

Above: For rural communication.

Below: Standing like sentinels.

The Editors Talk

Our Cover Picture

The effects of a deficiency of potash on the growth of Johnsongrass are illustrated on our cover this month. Because Johnsongrass is a sorghum, the signs of potash starvation on the leaves are somewhat similar to those appearing on sorghum and corn. They start with a reddish streaking along with marginal firing. In aggravated cases, a reddish spotting may also appear. The lower half of the cover illustration shows the effect of potash on growth when applied along with nitrogen and phosphorus.

On soils low in phosphorus and potash, both phosphorus (a purple coloring) and potash deficiency symptoms appear as soon as nitrogen is applied to the soil. The potash deficiency symptoms are even greater after phosphate is brought into the picture. Johnsongrass on many meadows, however, shows both phosphorus and potash deficiency symptoms when no fertilizer is used. This is due to the unusually low phosphate and potash in soils resulting from the removal of hay for many years without applying any fertilizer whatever.

According to "Grass," 1948 Yearbook of Agriculture published by the U. S. Department of Agriculture, Johnsongrass is different from all other species of sorghum in that it is a perennial that spreads by vigorous rootstocks. The stems, leaves, and heads of Johnsongrass resemble those of Sudangrass, although it seldom grows so tall. It was brought from Turkey about 1830, and has spread throughout the South.

"Johnsongrass grows wherever cotton is produced and thrives where moisture is abundant. Its seed fertility is high. Two or three crops of hay are frequently harvested a season; yields of more than 51 tons are common. It is valuable for pasture and is grown with several winter annual legumes. Yields of seed may reach 8 to 10 bushels an acre.

"Johnsongrass may contain small quantities of prussic acid, but rarely are livestock poisoned by it. Johnsongrass is condemned by many people, but it does have a profitable place in livestock production in many sections of the South."

The article "Johsongrass a Menace—True or False?" by Dr. T. C. Tucker of Mississippi State College on page six of this issue gives considerably more information on this plant which so widely for so many years was considered a great pest and now is held in such esteem by some that its profitable fertilization is subject for research. Dr. Tucker discusses the history of the prairie soils, soil testing data, etc., and says that if Johnsongrass is the best crop for such land, we need to know how to grow better Johnsongrass and more about the potential of the plant. Information as to the type and magnitude of nutrient responses and interactions of nutrients as well as satisfactory fertilization rates is needed. The effect of these fertilizer treatments on the quality and composition of hay is also of importance.

Without doubt, many of the observations which Dr. Tucker has made on Johnsongrass in Mississippi will be of interest and applicable in other sections of the South turning to livestock production in their diversification programs.

Fertilizer Acceptance and Use by Farmers

After the results of research establish profit and additional benefits from the use of a fertilizer, what are the factors affecting its acceptance and use by farmers? To throw some light on the subject, in 1953 Iowa State College and the Tennessee Valley Authority undertook a research project to determine (1) characteristics of Iowa farmers who use varying amounts of fertilizer and different fertilization practices, (2) informational sources important in the acceptance and use of fertilizer, (3) extent of use and handling of fertilizer on the farm, and (4) quantitative relationships between fertilizer use and specified factors considered to influence fertilizer use. A scientifically selected Statewide sample of 532 farms was the basis for the study.

Although the amount of fertilizer used in Iowa increased from 9,000 tons in 1938 to over 600,000 tons in 1953, it still was much below the level considered optimum by soil scientists, economists, and successful farmers. Therefore, the information to be gained would be of value not only in Iowa but in other states where despite a rapid increase, fertilizer consumption still had not attained agronomically desirable levels. It was hoped that the information would provide a basis for improved education, sales, and production activities relating to fertilizer and its efficient integration into farming.

All of the findings of the study cannot, of course, be discussed here. They will be found in Special Report No. 16, Agricultural Experiment Station, Iowa State College, published in June 1956. A few of the notations in the summary include the fact that the 69% of the farmers using commercial fertilizer when compared with the non-users had relatively larger amounts of capital invested in their farms, larger farms, more years of formal education, were younger, and had had fewer years of farming experience. They also had used soil tests extensively as a basis for fertilizer use.

It also disclosed that farmers need to see and hear about increased crop yields and greater net returns from fertilizer use on neighboring farms. Neighbors and mass media are the most important sources of information influencing farmers to accept fertilizer use. Iowa farmers go to State College representatives and to fertilizer dealers and salesmen to learn about a new fertilizer product.

Appreciable differences in fertilizer use were indicated among areas and crops. Corn was fertilized more extensively than any other crop. Over half of all farmers considered topdressing on permanent pasture, as well as on supplemental pasture grasses, and on land in oats as improved use practices. The farmers recognized the need to change the crop rotation when fertilizer is used.

Three fourths of the users preferred the 80-pound bag. Fertilizer was stored on the farm for the 1953 crop season by 44 per cent of the users. Thirty-seven per cent reported some difficulty in spreading commercial fertilizer. Tenant-operators estimated that they could profitably spend larger amounts of money for fertilizer than owner-operators. Lack of capital was the most important limitation to the use of fertilizer at the estimated optimum level. The amount of fertilizer used the previous year and size of farm were significantly related to the amounts of fertilizer used on owner- and tenant-operated farms.

The Report states that the potential of increased fertilizer use exists in the sense that the value of crop response is considerably greater than the cost of the fertilizer on many Iowa farms. The practicability of increased fertilizer use depends particularly on the economic characteristics of farms not now using fertilizer; it depends on the attitudes of these operators toward fertilizer use and their understanding of the beneficial effects of fertilizer. Expanded fertilizer use also depends on greater knowledge of the factors associated with fertilizer use by those who are now using fertilizer but not at the most profitable level.

Season Average Prices Received by Farmers for Specified Commodities *

Crop Year	Cotton Cents per lb. Aug.-July	Tobacco Cents per lb.	Potatoes Cents per bu. July-June	Sweet Potatoes Cents per bu. July-June	Corn Cents per bu. Oct.-Sept.	Wheat Cents per bu. July-June	Hay [1] Dollars per ton July-June	Cottonseed Dollars per ton July-June	Truck Crops ....
Av. Aug. 1909–July 1914....	12.4	10.0	69.7	87.8	64.2	88.4	11.87	22.55	....
1930.....	9.5	12.8	91.2	108.1	59.8	67.1	11.06	22.04	....
1931.....	5.7	8.2	46.0	72.6	32.0	39.0	8.69	8.97	....
1932.....	6.5	10.5	38.0	54.2	31.9	28.2	6.20	10.33	....
1933.....	10.2	13.0	82.4	69.4	52.2	74.4	8.09	12.88	....
1934.....	12.4	21.3	44.6	79.8	81.5	84.8	13.20	33.00	....
1935.....	11.1	18.4	59.3	70.3	65.5	83.2	7.52	30.54	....
1936.....	12.4	23.6	114.2	92.9	104.4	102.5	11.20	33.36	....
1937.....	8.4	20.4	52.9	78.0	51.8	96.2	8.74	19.51	....
1938.....	8.6	19.6	55.7	69.8	48.6	56.2	6.78	21.79	....
1939.....	9.1	15.4	69.7	73.4	56.8	69.1	7.94	21.17	....
1940.....	9.9	16.0	54.1	85.4	61.8	68.2	7.59	21.73	....
1941.....	17.0	26.4	80.8	92.2	75.1	94.4	9.70	47.65	....
1942.....	19.0	36.9	117.0	118.0	91.7	110.0	10.80	45.61	....
1943.....	19.9	40.5	131.0	206.0	112.0	136.0	14.80	52.10	....
1944.....	20.7	42.0	150.0	190.0	109.0	141.0	16.50	52.70	....
1945.....	22.5	36.6	143.0	204.0	127.0	150.0	15.10	51.10	....
1946.....	32.6	38.2	124.0	218.0	156.0	191.0	16.70	72.00	....
1947.....	31.9	38.0	162.0	217.0	216.0	229.0	17.60	85.90	....
1948.....	30.4	48.2	155.0	222.0	129.0	200.0	18.45	67.20	....
1949.....	28.6	45.9	128.0	214.0	124.0	188.0	16.50	43.40	....
1950.....	40.1	51.7	91.7	173.0	153.0	200.0	16.70	86.50	....
1951.....	37.9	51.1	163.0	304.0	166.0	211.0	19.50	69.30	....
1952.....	34.6	49.9	198.0	338.0	153.0	209.0	19.95	69.60	....
1953.....	32.3	52.2	78.1	244.0	148.0	204.0	17.45	52.60	....
1954.....	33.6	51.4	123.0	216.0	143.0	214.0	17.35	60.30	....
1955									
August.....	32.74	50.6	75.2	179.0	130.0	190.0	15.25	50.10	....
September...	33.77	51.5	71.3	142.0	124.0	192.0	15.55	43.70	....
October.....	32.83	55.0	72.3	144.0	114.0	194.0	15.75	43.50	....
November...	32.42	52.5	82.9	168.0	109.0	194.0	16.05	44.30	....
December....	31.19	57.2	80.7	203.0	115.0	195.0	16.55	45.00	....
1956									
January.....	30.67	51.3	99.4	199.0	116.0	195.0	16.55	45.50	....
February....	31.00	35.4	114.0	198.0	118.0	195.0	16.45	46.20	....
March.....	31.64	....	134.0	209.0	120.0	197.0	16.15	46.80	....
April.....	32.50	....	172.0	217.0	132.0	203.0	16.25	46.90	....
May.....	31.96	54.0	219.0	231.0	139.0	200.0	16.15	47.30	....
June.....	32.29	51.0	265.2	317.0	142.0	193.0	15.05	47.40	....
July.....	32.36	48.0	311.4	380.0	143.0	190.0	14.85	49.00	....
August.....	31.13	50.1	140.0	218.0	145.0	193.0	15.25	51.00	....
Index Numbers (Aug. 1909–July 1914 = 100)									
1930.....	77	128	131	123	93	76	93	98	128
1931.....	46	82	66	83	50	44	73	40	107
1932.....	52	105	55	62	50	43	52	46	100
1933.....	82	130	118	79	81	84	68	57	90
1934.....	100	213	64	91	127	96	111	146	94
1935.....	90	184	85	80	102	94	63	135	116
1936.....	100	236	164	106	163	116	94	148	108
1937.....	68	204	76	89	81	109	74	87	114
1938.....	69	196	80	79	76	64	57	97	96
1939.....	73	154	100	84	88	78	67	94	98
1940.....	80	160	78	97	96	77	64	96	122
1941.....	137	264	116	105	117	107	82	211	138
1942.....	153	369	168	134	143	124	91	202	178
1943.....	160	405	188	235	174	154	125	231	270
1944.....	167	420	214	216	170	160	139	234	236
1945.....	181	366	205	232	198	170	127	227	240
1946.....	263	382	178	248	212	209	141	319	217
1947.....	257	380	232	248	336	259	148	381	262
1948.....	245	482	222	253	201	226	155	298	253
1949.....	231	459	184	244	193	213	139	192	232
1950.....	323	517	132	197	238	226	141	384	211
1951.....	306	512	233	346	259	239	164	307	269
1952.....	279	499	284	385	238	236	168	309	274
1953.....	260	522	112	278	231	231	147	233	240
1954.....	270	514	176	246	223	242	146	267	228
1955									
August.....	264	506	108	204	202	215	128	222	211
September...	272	515	102	162	193	217	131	194	230
October.....	265	550	104	164	178	219	133	193	223
November...	261	525	119	191	170	219	135	196	231
December....	252	572	118	231	179	221	139	200	231
1956									
January.....	247	513	143	227	181	221	139	202	244
February....	250	354	164	226	184	221	139	205	244
March.....	255	...	192	238	187	223	136	208	214
April.....	262	...	247	247	206	230	137	208	202
May.....	258	540	314	263	217	226	136	210	239
June.....	260	510	389	361	221	218	127	210	345
July.....	261	480	455	396	223	215	125	217	351
August.....	251	501	201	248	226	218	128	226	230

Wholesale Prices of Phosphates and Potash * *

	Superphosphate, Baltimore, per unit	Florida land, pebble, 68% f.o.b. mines, bulk, per ton	Tennessee phosphate rock, 75% f.o.b. mines, bulk, per ton	Muriate of potash bulk, per unit, c.i.f. Atlantic and Gulf ports [2]	Sulphate of potash in bags, per unit, c.i.f. Atlantic and Gulf ports [2]	Sulphate of potash magnesia, per ton, c.i.f. Atlantic and Gulf ports [2]	Manure salts bulk, per unit, c.i.f. Atlantic and Gulf ports [2]
1910–14	$0.536	$3.61	$4.88	$0.714	$0.953	$24.18	$0.657
1930	.542	3.18	5.50	.681	.973	26.92	.618
1931	.485	3.18	5.50	.681	.973	26.92	.618
1932	.458	3.18	5.50	.681	.963	26.90	.618
1933	.434	3.11	5.50	.662	.864	25.10	.601
1934	.487	3.14	5.67	.486	.751	22.49	.483
1935	.492	3.30	5.69	.415	.684	21.44	.444
1936	.476	1.85	5.50	.464	.708	22.94	.505
1937	.510	1.85	5.50	.508	.757	24.70	.556
1938	.492	1.85	5.50	.533	.774	15.17	.572
1939	.478	1.90	5.50	.521	.751	24.52	.570
1940	.516	1.90	5.50	.517	.730	24.75	.573
1941	.547	1.94	5.64	.522	.780	25.55	.367
1942	.600	2.13	6.29	.522	.810	25.74	.205
1943	.631	2.00	5.93	.522	.786	25.35	.195
1944	.645	2.10	6.10	.522	.777	25.35	.195
1945	.650	2.20	6.23	.522	.777	25.35	.195
1946	.671	2.41	6.50	.508	.769	24.70	.190
1947	.746	3.05	6.60	.432	.706	18.93	.195
1948	.764	4.27	6.60	.397	.681	14.14	.195
1949	.770	3.88	6.22	.397	.703	14.14	.195
1950	.763	3.83	5.47	.371	.716	14.33	.195
1951	.813	3.98	5.47	.401	.780	15.25	.200
1952	.849	3.98	5.47	.401	.793	15.25	.200
1953	.878	....	....	.410	.793	15.25	.200
1954	.895	....	....	.405	.791	15.27	.200
1955							
August	.895	....	....	.380	.735	14.00	.193
September	.895	....	....	.380	.735	14.00	.193
October	.895	....	....	.380	.735	14.00	.193
November	.895	....	....	.380	.735	14.00	.193
December	.895	....	....	.380	.735	14.00	.193
1956							
January	.895	....	....	.380	.735	14.00	.193
February	.895	....	....	.380	.735	14.00	.193
March	.895	....	....	.380	.735	14.00	.193
April	.895	....	....	.380	.735	14.00	.193
May	.895	....	....	.380	.735	14.00	.193
June	.895	....	....	.360	.720	13.45	.177
July	.895	....	....	.380	.735	14.00	.177
August	.895	....	....	.380	.735	14.00	.177
			Index Numbers (1910-14 = 100)				
1930	101	88	113	95	102	111	94
1931	90	88	113	95	102	111	94
1932	85	88	113	95	101	111	94
1933	81	86	113	93	91	104	91
1934	91	87	110	68	79	93	74
1935	92	91	117	58	72	89	68
1936	89	51	113	65	74	95	77
1937	95	51	113	71	79	102	85
1938	92	51	113	73	81	104	87
1939	89	53	113	73	79	101	87
1940	96	53	113	72	77	102	87
1941	102	54	110	73	82	106	87
1942	112	59	129	73	85	106	84
1943	117	55	121	73	82	105	83
1944	120	58	125	73	82	105	83
1945	121	61	128	73	82	105	83
1946	125	67	133	71	81	102	82
1947	139	84	135	70	74	78	83
1948	143	118	135	67	72	58	83
1949	144	108	128	67	74	58	83
1950	142	106	112	68	75	59	83
1951	152	110	112	72	82	63	83
1952	158	110	112	72	83	63	83
1953	164	...	...	73	83	63	83
1954	167	...	...	72	83	63	83
1955							
August	167	...	...	69	77	58	82
September	167	...	...	69	77	58	82
October	167	...	...	69	77	58	82
November	167	...	...	69	77	58	82
December	167	...	...	69	77	58	82
1956							
January	167	...	...	69	77	58	82
February	167	...	...	69	77	58	82
March	167	...	...	69	77	58	82
April	167	...	...	69	77	58	82
May	167	...	...	69	77	58	82
June	167	...	...	66	76	56	80
July	167	...	...	69	77	58	80
August	167	...	...	69	77	58	80

Wholesale Prices of Ammoniates * *

	Nitrate of soda bulk per unit N	Sulphate of ammonia bulk per unit N	Cottonseed meal S. E. Mills per unit N	Fish, scrap, dried 11–12% ammonia, 15% bone phosphate, f.o.b. factory bulk per unit N	Tankage 11% ammonia, 15% bone phosphate, f.o.b. Chicago, bulk, per unit N	High grade ground blood, 16–17% ammonia, Chicago, bulk, per unit N
1910–14	$2.68	$2.85	$3.50	$3.53	$3.37	$3.52
1930	2.47	1.81	4.78	4.96	3.79	4.58
1931	2.34	1.46	3.10	3.95	2.11	2.46
1932	1.87	1.04	2.18	2.18	1.21	1.36
1933	1.52	1.12	2.95	2.86	2.06	2.46
1934	1.52	1.20	4.46	3.15	2.67	3.27
1935	1.47	1.15	4.59	3.10	3.06	3.65
1936	1.53	1.23	4.17	3.42	3.58	4.25
1937	1.63	1.32	4.91	4.66	4.04	4.80
1938	1.69	1.38	3.69	3.76	3.15	3.53
1939	1.69	1.35	4.02	4.41	3.87	3.90
1940	1.69	1.36	4.64	4.36	3.33	3.39
1941	1.69	1.41	5.50	5.32	3.76	4.43
1942	1.74	1.41	6.11	5.77	5.04	6.76
1943	1.75	1.42	6.30	5.77	4.86	6.62
1944	1.75	1.42	7.68	5.77	4.86	6.71
1945	1.75	1.42	7.81	5.77	4.86	6.71
1946	1.97	1.44	11.04	7.38	6.60	9.33
1947	2.50	1.60	12.72	10.66	12.63	10.46
1948	2.86	2.03	12.94	10.59	10.84	9.85
1949	3.15	2.29	10.11	13.18	10.73	10.62
1950	3.00	1.95	11.01	11.70	10.21	9.36
1951	3.16	1.97	13.20	10.92	10.18	10.09
1952	3.34	2.09	13.95	11.27	9.72	9.16
1953	3.26	2.27	11.04	11.19	7.39	7.09
1954	3.07	2.20	11.50	11.63	9.72	9.85
1955						
August	2.98	2.07	9.88	11.12	7.04	6.86
September	2.98	2.05	9.30	11.60	6.75	6.53
October	2.98	2.07	9.17	13.01	7.47	7.16
November	2.98	2.07	8.71	13.10	6.14	6.23
December	2.98	2.12	9.21	12.93	5.66	6.00
1956						
January	2.98	2.12	9.43	12.75	5.58	5.58
February	2.98	2.12	8.69	12.15	5.77	5.69
March	2.98	2.12	8.30	11.89	5.92	5.92
April	2.98	2.12	8.31	11.66	5.77	5.71
May	2.98	1.70	8.67	11.80	6.60	6.37
June	2.98	1.56	8.72	11.29	6.37	6.23
July	2.98	1.56	9.37	10.89	6.80	6.37
August	2.98	1.56	9.99	11.26	6.53	6.37
Index Numbers (1910-14 = 100)						
1930	92	64	137	141	112	130
1931	88	51	89	112	63	70
1932	71	36	62	62	36	39
1933	59	39	84	81	97	71
1934	59	42	127	89	79	93
1935	57	40	131	88	91	104
1936	59	43	119	97	106	131
1937	61	46	140	132	120	122
1938	63	48	105	106	93	100
1939	63	47	115	125	115	111
1940	63	48	133	124	99	96
1941	63	49	157	151	112	126
1942	65	49	175	163	150	192
1943	65	50	180	163	144	189
1944	65	50	219	163	144	191
1945	65	50	223	163	144	191
1946	74	51	315	209	196	265
1947	93	56	363	302	374	297
1948	107	71	370	300	322	280
1949	117	80	289	373	318	302
1950	112	68	315	331	303	266
1951	118	69	377	310	302	287
1952	125	74	399	319	288	260
1953	122	80	315	317	219	201
1954	114	77	329	330	288	280
1955						
August	111	73	282	315	209	195
September	111	72	266	329	200	186
October	111	73	262	369	222	203
November	111	73	249	371	182	177
December	111	74	263	366	168	170
1956						
January	111	74	269	361	166	159
February	111	74	248	344	171	162
March	111	74	237	337	176	168
April	111	74	237	330	171	162
May	111	60	248	334	196	181
June	111	55	249	320	189	177
July	111	55	268	308	202	181
August	111	55	285	319	194	181

Combined Index Numbers of Prices of Fertilizer Materials, Farm Products and All Commodities

	Farm prices*	Prices paid by farmers for commodities bought*	Wholesale prices of all commodities†	Fertilizer material‡	Chemical ammoniates	Organic ammoniates	Superphosphate	Potash**
1930.....	125	140	126	105	72	131	101	99
1931.....	87	119	107	83	62	83	90	99
1932.....	65	102	95	71	46	48	85	99
1933.....	70	104	96	70	45	71	81	95
1934.....	90	118	109	72	47	90	91	72
1935.....	109	123	117	70	45	97	92	63
1936.....	114	123	118	73	47	107	89	69
1937.....	122	130	126	81	50	129	95	75
1938.....	97	122	115	78	52	101	92	77
1939.....	95	121	112	79	51	119	89	77
1940.....	100	122	115	80	52	114	96	77
1941.....	124	130	127	86	56	130	120	77
1942.....	159	149	144	93	57	161	112	77
1943.....	193	165	151	94	57	160	117	77
1944.....	197	174	152	96	57	174	120	76
1945.....	207	180	154	97	57	175	121	76
1946.....	236	197	177	107	62	240	125	75
1947.....	276	231	222	130	74	362	139	72
1948.....	287	250	241	134	89	314	143	70
1949.....	250	240	226	137	99	319	144	70
1950.....	258	246	232	132	89	314	142	72
1951.....	302	271	258	139	93	331	152	76
1952.....	288	273	251	144	98	333	158	76
1953.....	258	262	247	139	100	269	164	77
1954.....	249	264	248	142	95	311	167	76
1955								
August....	233	260	248	133	91	252	167	72
September.	235	259	250	132	91	244	167	72
October...	230	261	250	134	91	259	167	72
November.	225	259	250	131	91	235	167	72
December..	223	259	250	131	92	232	167	72
1956								
January...	226	259	252	131	92	232	167	72
February..	226	259	252	130	92	225	167	72
March....	228	261	254	130	92	222	167	72
April.....	235	261	257	130	92	219	167	72
May.....	242	264	257	128	85	236	167	72
June.....	247	264	257	126	82	231	167	70
July.....	244	266	257	128	82	242	167	72
August....	237	267	259	128	82	246	167	72

* U. S. D. A. figures, revised January 1950. Beginning January 1946 farm prices and index numbers of specific farm products revised from a calendar year to a crop-year basis. Truck crops index adjusted to the 1924 level of the all-commodity index.

† Department of Labor index converted to 1910-14 base.

‡ The index numbers of prices of fertilizer materials are based on original study made by the Department of Agricultural Economics and Farm Management, Cornell University, Ithaca, New York. These indexes are complete since 1897. The series was revised and reweighted as of March 1940 and November 1942.

[1] Beginning July 1949, baled hay prices reduced by $4.75 a ton to be comparable to loose hay prices previously quoted.

[2] Potash salts quoted F.O.B. mines; manure salts since June 1941; other carriers since June 1947.

** Where range of prices for fertilizer material is quoted, average figure is used. The weighted average of prices actually paid for potash is lower than the annual average because since 1926 over 90% of the potash used in agriculture has been contracted for during the discount period.

REVIEWS

This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soils, Crops, and Economics. A file of this department of BETTER CROPS WITH PANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.

Fertilizers

"1956 and 1957 General Recommendations, Fertilizers for Alaska," Agr. Ext. Serv., Univ. of Alaska, Palmer, Alaska, Cir. 513, Rev. Dec. 1955, W. M. Laughlin, H. J. Hodgson, M. F. Babb, and A. H. Mick.

"1955 Fertilizing Materials," State Dept. of Agr., Sacramento, Calif., Spec. Bul. 260, May 1956.

"Commercial Fertilizer Results with Winter Wheat and Rye, 1956," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Outstate Testing Cir. 53, Aug. 1956, G. W. Lowrey, R. A. Olson, and P. L. Ehlers.

"Fertilizers Mean Profits to Nevada Farmers," Agr. Exp. Sta., Univ. of Nev., Reno, Nev., Bul. 189, Aug. 1955, V. E. Spencer and W. A. Goodale.

"1956 Fertilizers for Field Crops," Agr. Ext. Serv., Cornell Univ., Ithaca, N. Y., Ext. Bul. 780, Rev. Feb. 1956.

"Fertilization and Spacing of Irrigated Corn on the Belle Fourche Irrigation Project," Agr. Exp. Sta., S. Dak. State College, Brookings, S. Dak., Cir. 120, Feb. 1956, B. L. Baird and J. J. Bonnemann.

"Cotton Fertilizer Tests at the Blackland Experiment Station, 1952-55," Agr. Exp. Sta., Texas A. & M. College, College Station, Texas, Prog. Rpt. 1883, July 1956, E. D. Cook and W. R. Parmer.

"Effects of a Starter Solution and Fertilizer on Sweet Potatoes in South-Central Texas," Agr. Exp. Sta., Texas A. & M. College, College Station, Texas, Prog. Rpt. 1886, Aug. 1956, D. R. Paterson, J. M. Coruthers, and R. L. Smith, Jr.

"Fertilizers for Lawns in the Winter Garden Area," Agr. Exp. Sta., Texas A. & M. College, College Station, Texas, Misc. Pub. 174, July 1956, R. A. Schwartzbeck.

"Fertilizers Can Cut Production Costs," Agr. Ext. Serv., Univ. of Wis., Madison, Wis., Spec. Cir. 47, June 1956, C. J. Chapman, K. C. Berger, H. H. Hull, and J. T. Murdock.

Soils

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Withdrawals From Soil Bank . . .

(*From page* 16)

TABLE I. (CONTINUED)—AMOUNT OF NUTRIENTS USED BY CROPS GROWN IN THE PACIFIC NORTHWEST

Crop	Part	Yield per acre	Pounds Removed					
			N	P_2O_5	K_2O	CaO	S	MgO
FRUIT								
Apples	fruit	500 pkd bx	24	7	31	3	9	6
	leaves	1,500 lbs.	20	3	15			
Apricots	fruit	6 tons	23	8	36	2		
	leaves	2,000 lbs.	40	6	40			
Blackberry	fruit	4 tons	18	5	18			
	leaves	2,000 lbs.	20	3	15			
	new wood	5 tons	55	15	25			
Pears	fruit	10 tons	18	6.8	26.8	4		
	leaves	2,400 lbs.	16.8	2.9	9.6			
	new wood	600 lbs.	1.8	0.6	1.5			
Peaches	fruit	12 tons	28.8	20.4	94.5	4	4	8
	leaves	5,300 lbs.	47.7	8	42			
	new wood	1,500 lbs.	8.6	2	2.5			
Prunes	fruit	8 tons	29.2	10.8	49.6	4		
	leaves	2,000 lbs.	15.2	3.5	16.0			
	new wood	700 lbs.	3.5	1.5	2.0			
Raspberry	fruit	3 tons	10.5	4.5	12.0			
	leaves	1,000 lbs.	13.5	2.7	6.3			
	canes	4,000 lbs.	14.0	4.0	10.0			
Strawberry	fruit	5 tons	15	6	25			

Crop	Part	Yield per acre	Pounds Removed					
			N	P_2O_5	K_2O	C_aO	S	MgO
GRAIN CROPS								
Barley	grain	3,000 lbs.	62	28	22	4	4	6
	straw	4,000 lbs.	52	12	84	18	10	5
Oats	grain	2,000 lbs.	40	16	12	4	4	4
	straw	3,000 lbs.	18	6	37	15	6	4
Wheat	grain	30 bu.	25	16	9	1	2	3
	straw	1¼ tons	15	4	21	6	4	2
Corn (field)	ear	60 bu.	57	24	27	1	5	6
	stover	2 tons	36	16	46	23	6	5
OTHER CROPS								
Cantaloupes	fruit	14,000 lbs.	31	11	56			
	vines & leaves	4,000 lbs.	14	3	24			
Hops	cones	2,000 lbs.	34	22	30			
	vines & leaves	5,000 lbs.	32	15	67			
Sugar beets	roots	30,000 lbs.	75	24	87	31	5	12
	tops	8,000 lbs.	28	6	13			
Walnuts	nuts & hulls	2,000 lbs.	11	3	16	3		

N = Nitrogen; P_2O_5 = Phosphoric Acid; K_2O = Potash; CaO = Lime; S = Sulfur; MgO = Magnesia.

depleted the soil in many areas. The actual plant food removed by the grain is comparatively small and, from a plant-nutrient removal standpoint, a grain crop is certainly not "hard" on the soil.

On the other hand, legumes, such as alfalfa or clover, remove relatively large amounts of plant nutrients from the soil. These legumes do have the ability to fix nitrogen from the air, because of the nitrogen-fixing bacteria present on their roots. Legumes also hold the soil against erosion much better than many crops. However, the heavy removal from the soil of other nutrients such as phosphorus, potassium, calcium, sulfur, and magnesium, classes legumes above many other crops as potential soil robbers, rather than soil builders.

The idea that pasturing "rests" and restores the soil is another erroneous viewpoint. There is a net loss of mineral nutrients from the soil *each* year land is pastured, unless fertilizer is applied. The return of nutrients in the form of manures of animals on the pastures is usually not enough to offset the loss.

Under a green crop or a pasture program, removal of plant nutrients is

very heavy. The plants making up the pasture are grazed or cut when in a young, immature stage. At this stage of growth, the plants contain higher concentrations of mineral nutrients than when more mature, and therefore removal of plant nutrients is comparatively heavy under either of these pasturing systems. The fertility of pasture soil is often reduced because these facts are not realized. Proper measures should be taken to maintain and improve these soils. Remember, a crop of milk or meat taken from livestock farm lands removes nutrients just as other crops do.

The factor of soil depletion should be considered separately from the total crop requirements for growth. For instance, a sweet corn crop of 5 tons of ears and 4 tons of stalk requires as much total potash for growth as a potato crop of 12 tons of tubers and 4 tons of tops. However, the soil depletion or crop removal factor—which is the actual K_2O removed from the farm—is quite different. Thirty pounds of K_2O are removed by the sweet corn crop and 150 pounds by the potato crop.

A table of plant-food requirements for different crops shows big differences in this regard. This table points out the need for different fertilizers on the various crops. Any given level of available nutrients in the soil, as determined by the soil test, cannot be said to be sufficient or deficient for all kinds of crops on all soils. Soil-test interpretations need to take into consideration these differences in crop removal—a crop of 1,500 pounds of wheat utilized 30 pounds of K_2O in the grain and straw, while a crop of 4 tons of alfalfa hay utilizes about 170 pounds of K_2O in the forage.

Since crops vary greatly in their total nutrient requirements, in addition to the variation in the different elements needed and the removal of these elements from the farm, it is apparent that these factors influence the amount as well as the type of plant food to be used in order to obtain economical yield increases.

Johnsongrass a Menace . . .

(*From page* 8)

of 36,000 pounds per acre. What would it be for three to five cuttings? Then too, would fertilization make possible the profitable production of some other crop or crops on some of this land? Some farmers have from hundreds to more than a thousand acres devoted to Johnsongrass. These questions cannot be answered from information now available.

It may be suggested from the yield data that an immediate response can be expected from nitrogen alone. Such a practice would serve to intensify the fertility problem as the soil is further mined of phosphorus and potassium. The soil pH was 7.4 and the soil phosphorus and potassium levels were low. A response to phosphorus and a phosphorus-potassium interaction seemed to be indicated by the limited data.

Data in Table II show that the nitrogen treatment alone effects a more rapid removal of soil phosphorus and potassium. When both phosphorus and nitrogen were applied, an even greater amount of potassium was removed even though the percentage composition declined.

Figure I shows the rather striking response to the complete NPK treatment. The differences between the NPK—NP, and NP—NK treatments can be seen in Figures 2 and 3, respectively. These differences were even more pronounced at cutting time.

In this report of some preliminary work, few questions can be answered. More information is needed in order

TABLE II.—THE INFLUENCE OF DIFFERENT TREATMENTS ON THE COMPOSITION OF JOHNSONGRASS HAY.

Treatment	Composition					
	Per cent			Removal, lbs./A.		
	N	P	K	N	P	K
O	0.87	0.20	1.30	6.8	1.6	10.2
N	2.22	0.16	1.12	69.5	5.0	35.0
NK	2.13	0.21	2.18	69.5	6.9	71.2
NP	2.14	0.35	1.05	119.2	19.5	58.5
NPK	1.54	0.33	2.07	132.2	28.3	177.8

to make more efficient utilization of the type of land discussed. If Johnsongrass is the best crop for such land, we need to know how to grow better Johnsongrass and more about the potential of the plant. Information as to the type and magnitude of nutrient responses and interactions of nutrients as well as satisfactory fertilization rates is needed. The effect of these fertilizer treatments on the quality and composition of hay is also of importance. Well-replicated experiments designed to help answer some of these questions have been initiated.

Demonstrating Alfalfa Rules

(*From page* 26)

attendance and interest were such as to indicate them to be a success.

Reviewing four years of demonstrational efforts isolates some facts that emphasize the merits of the endeavor. The value of yield increases on the treated plots was enough to pay for the entire cost of the fertilizer with a sizable profit besides. In addition to increased yields, the alfalfa stands were successfully maintained on the treated plots while weeds and grass took over on the untreated areas. The results obtained offer convincing proof that alfalfa can be successfully grown and stands satisfactorily maintained if proper fertilization practices are combined with other proven production practices. This story is presently being carried to farmers in the form of eight rules for successful alfalfa production.

The rules are:

1. Select land suitable for alfalfa.
2. Prepare a compact, weed-free seedbed.
3. Select a high-yielding, winter-hardy variety.
4. Apply lime in adequate quantity.
5. Use an adequate amount of the right kind of fertilizer.
6. Inoculate seed properly.
7. Do the seeding job right.
8. Manage the stand carefully.

We believe the continued demonstration of the application of these eight rules will do much to push back the darkness associated with antiquated methods and create an atmosphere for the dawning of another day in alfalfa production that will not be hampered by the eclipse of failure and dissatisfaction that have been so difficult to overcome in the present one.

Fig. 1. Aerial application of complete fertilizer to forest trees. Stearman crop-dusting plane is applying 12-12-12 fertilizer at the rate of 400 pounds an acre at the Rutgers University Dairy Research Farm, Beemerville, New Jersey. This is believed to be the first application by air of fertilizer to a forest stand.

Use Plane To Spread Fertilizer on Woodland

AERIAL application of a complete fertilizer to forest trees has been made at the Rutgers University Dairy Research Farm, Beemerville, New Jersey, by the Rutgers Forestry Department and Nitrogen Division, Allied Chemical & Dye Corporation. It is believed to be the first such application ever made.

The fertilizer was spread over an 11-acre stand of red pine.

The purpose of the experiment is to improve the growth of the 28-year-old trees that are growing slowly because of low fertility soil, according to John Andresen of the State University Forestry Department.

Fertilizing of trees to get a greater volume of wood quicker is an entirely new concept in the United States, although it has been practiced for some time in Europe where there has been a shortage of wood for centuries.

Recent tests of fertilizing trees have indicated increases in growth ranging from 40 to 65 per cent. Current, larger-scale work is directed toward improvement of the fertilizing technique, which in practice could lead to more abundant, cheaper wood for the pulp and paper industries, continues the Rutgers forester.

The fertilizer applied at Beemerville was a standard agricultural mate-

rial with an analysis of 12 per cent nitrogen, 12 per cent phosphorus, and 12 per cent potash, the three primary plant foods. A crop-dusting Stearman airplane operated by Cherry Dusting Service of Pemberton applied the material at the rate of 400 pounds an acre in a spreading time of 6 minutes.

Measurements of the fertilized trees will be made after each growing season to determine the extent of their response to the fertilizer. Other experiments have shown that well-fertilized trees are greener, have longer needles, and are more healthy in general than trees growing without sufficient plant food.

Recently expanded pulp and paper production facilities are expected to put an even heavier drain on the Southeastern pine forests which now provide the bulk of pulpwood. Fertilization of these stands is expected to provide the key to greater volume as it did to agricultural crop production. . . . *News Bureau College of Agriculture, New Brunswick, New Jersey.*

"Grassland Farming" by Ford S. Prince, D. Van Nostrand Co., Inc., New York—441 pages, illus. 1956 ($9.00)

HERE is an outstanding book that brings together in easily readable form all the latest information on grassland farming in the northeastern section of the United States. Until now, such information has been available only from many scattered sources. The author has very carefully selected his material and used only that which is reliable and sound. Only someone, with such wide experience and training as the author has, could have done this. The book is written in a clear, concise way and is free from technical terms that would be unfamiliar to the ordinary reader. It was written with the practical man in view and, in that, it certainly is all that could be asked.

The book has 23 chapters dealing with such subjects as establishment of grassland crops, grass silage, pastures, seed mixtures individual grasses and legumes, the use of fertilizers and lime in grassland farming, and similar topics. At the end of each chapter there is a brief summary of the material handled in the chapter. This will be a boon to the busy man who can quickly find where his particular problem has been considered.

In addition to the summary, there is a list of questions at the end of each chapter. The questions are based on the material discussed, and the answers can be readily found. Many of the questions are of the kind that come from an audience after a talk by an extension worker or crop specialist. Each chapter also has a well-selected list of references for anyone who wishes to go into any subject in more detail.

This is a book that every county agent and vo-ag teacher will want to have on his shelf for ready reference. He can depend on getting all the up-to-the-minute, reliable information on the important subject of grassland farming. The grassland farmer, for whom it was especially written, will find it particularly useful. The book is not designed for use as a "text" in either college or secondary schools, but its wealth of practical information on all phases of grassland farming is sure to establish it as a "must" reference.

The book is well illustrated throughout with carefully chosen pictures. Every picture has a definite story to tell and does it in an effective manner. The pictures illustrate modern equipment, machinery, and methods. . . .

T. E. Odland, University of Rhode Island, Kingston, Rhode Island.

Plants Need Balanced Diet

"A plant uses at least 14 foods in its growth. These are nitrogen, phosphorus, potash, calcium, oxygen, hydrogen, carbon, magnesium, iron, sulphur, boron, manganese, copper, and zinc. Soils are generally or most frequently deficient in the first three. For that reason, commercial fertilizers usually supply only these. Occasionally the secondary or trace elements are included in mixed fertilizers, but their requirement, being so small, is usually most effectively applied by spray solutions. Of the three major elements mentioned, *Nitrogen* promotes particularly the development of stem and leaf and is required during early stages of growth. Too little nitrogen results in stunted growth with yellowish foliage. Too much induces rank growth, delays seed formation and ripening, and tends to make plants more susceptible to diseases. *Phosphorus* stimulates root growth in the early stages and promotes seeding or fruit formation in the later stages of growth. It is, therefore, especially important when early ripening of a crop is desired. *Potash* is essential to the formation of the starches of potatoes and grains, the sugars of fruits and vegetables, the fibrous material of plants. It promotes increased yields of better quality and is particularly required by clovers and other legumes. An ample supply of potash in the soil helps to prevent disease and to lessen the effect of execessive nitrogen application." *(Farm News* #787, *Department of Agriculture, Ottawa, Canada.)*

Fertilizer and the Florida Farmer

(*From page* 22)

million pounds to meet present fertilizer recommendations.

The phosphorus level in the cultivated soils of Florida varies greatly between soil areas and even within soil areas. These variations have been brought about to a large extent by differences in the past fertilization practices since most virgin soils in the State are low in available phosphorus. Under heavy fertilization the level of phosphorus gradually increases; that is to say, more phosphorus is added in fertilizers than is removed by crops or lost by leaching or erosion. For example, an estimated 51 million pounds of P_2O_5 are applied annually to vegetable crops while only about 12.5 million pounds are contained in the harvested crops. For citrus this figure is estimated at 48 million pounds added as compared to 14 million pounds removed in the fruit.

The supply of potassium in the virgin soils of Florida may be higher than that of nitrogen or phosphorus, but the available potassium in cultivated soil is generally critically low. Present potash applications for most crops do not equal that removed from the soil by crops; and since additional quantities may be lost by leaching or erosion, it can be safely said that the soils of the State are becoming progressively poorer in this essential plant food.

In spite of the fact that 4-7-5 has continued to be the most popular fertilizer grade sold in the State for many years, there is a trend away from 1:2:1 and similar ratios toward 1:1:1 and 2:1:2

ratios. For example, the 6-6-6 grade jumped from tenth to second place in popularity since 1943-44 and the grades in the 1:1:1 ratio accounted for 20% of all sales last year. There also continues to be slow progress toward higher analysis fertilizers. The average $N\text{-}P_2O_5\text{-}K_2O$ content of all fertilizers has risen from about 17.1% to 22.2% as pointed out earlier. The percentage plant-food content can be expected to increase slowly to about 26% to 30%. It probably will not materially exceed this level due to the need for sulfur which usually is absent in the more concentrated fertilizers.

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Potassium—The Alkali of Life

(*From page* 12)

In review of this section, the major fraction of body potassium plays an active part in many energy storing and releasing and other enzymatic reactions in animal metabolism. This is in equilibrium with the remaining free ions in the body fluids. This remainder displays osmotic and solubilizing properties but meets only a small part of the body needs in this respect. The difference is made up by sodium ions.

Deficiency and Toxicity

We will now consider the effects of insufficient potassium. This may arise from a low supply in an otherwise sufficient diet, or from simple lack of food intake (48). It develops more rapidly when there are losses from diarrhea (133) or vomiting (38, 97, 151). Any deviation from the optimum concentration of the free ion in plasma and extracellular fluid leads to faulty energy exchanges. This means muscular weakness (skeletal, heart, respiratory), nerve slow-down to the point of mental confusion, and faulty function of the kidney and other glands. MacPhee (109) has pointed out that deficiency may occur in any group of cells without reflecting that of the plasma (free ion fraction) or that of other cells such as the red blood cells. This would be a deficiency of some other constituent of the cells and not a true lack of potassium. Toxicity, on the other hand, is always related to excess in plasma and extracellular fluids.

Work with deficient diets in rats has shown the effect on the heart by lowered blood pressure (61) and fibrosis of the muscle (153). Cannon (28) has studied the degeneration of the heart in this connection. Dogs develop excessive fluid exchange followed by progressive paralysis and death due to respiratory failure (153).

Black and Milne (18), using themselves as subjects, report the effects of low potassium diets. Extracellular alkalosis developed, but time may not have been sufficient to develop muscular weakness. Balahd and Bassett (8) made a similar study and noted in addition that, due to renal losses, balance was not obtained on the experimental diets. Far more extreme losses are found in clinical disease. Cole (32) considers hypopotassemia the immediate cause of death in many other conditions and mentions the renal loss in the presence of great need. The low potassium associated with sprue (92) leads to flaccid paralysis and respiratory death with heart and kidney lesions. Cannon (28) has studied the degeneration of the heart in this connection.

We again note the toxicity of sodium in the low potassium states (27) and

the increased potassium toxicity in low plasma sodium conditions (98). At the same time there are dangers in insufficient supplies of both (63). Plasma sodium levels may be raised by potassium administration when the plasma potassium is at a low normal value (98). This is explained as reduction of edema and release of intracellular sodium.

Toxic concentrations can result from rapid liberation of potassium from cells as the result of injury or over-activity (50). Over-correction of deficiency by injection (74) always has this danger since the amount in the plasma is relatively small. Protection is given by metabolites such as glucose with insulin (119) and glutathione (114), which transfer it to the intracellular combinations. Correction of the potassium to calcium ratio may also be of value.

To Be Continued in November Issue.

White Clover Years . . .

(*From page* 18)

ion might be enough to invite white clover when at the lower figure the deficient calcium was prohibiting it.

When the saturations of the soil by calcium combined with magnesium were considered, the values fluctuated between a low of 75.45% and a high of 90.85% during those years. The high value represents a soil well stocked with these two essentials for protein-producing crops like white clover and other legumes in general. Thus, we might expect the white clover to come back because the fertility improved so much in respect to calcium. Since none was applied, the incidence of the white clover suggests that either the reserve soil minerals or those recently blown in were weathered enough during the absence of the clover to bring the active fertility up again to meet the needs of the clover in this respect.

The total exchange capacity of the soil remained constant during those years. The figures for the four samplings within the seven-year period were 19.98, 19.06, 19.20, and 19.35 milligram equivalents, respectively.

Of particular interest was the increase in the organic matter of the soil as a result of growing the bluegrass. As per cent of the dry soil, the figures for the four years cited were 3.53, 3.71, 4.07, and 4.29, respectively. The total nitrogen also increased according to the following per cents of the dry soil, 0.173, 0.185, 0.190, and 0.205, respectively.

One might have expected this increase in nitrogen to give it more activity in growing more bluegrass. But while this more stable organic matter of the soil was increasing, it was not becoming any the less woody or less carbonaceous to increase its rate of liberating its nitrogen, phosphorus, potassium, calcium, or any other of its nutrients. This was shown by the nearly constant carbon-nitrogen ratios of it. Those values during the four sampled years cited for the seven-year period were respectively 11.85, 11.63, 12.41, and 12.15. The organic matter seemed relatively too stable for any shift to speedy decomposition without tillage. Thus the bluegrass sod was building up the more permanent organic matter. It was increasing the percentages saturation of the soil with those inorganic essentials by which the white clover would be encouraged, since as a legume it needed little nitrogen from the soil and could build its own protein-rich organic matter from atmospheric nitrogen. This organic matter, dropped back to the soil on the death of the white clover, would provide extra and active nitrogen. It would invite subsequent lush growth of the bluegrass. This non-legume would compete with the next crop of clover for other fertility elements liberated because the

added nitrogen would hasten the decomposition of the more carbonaceous soil organic matter to set them free or make them active again.

Thus we can visualize the bluegrass exhausting the soil's supply of active nitrogen and of other active fertility, and building these into more stable organic matter even with an increase in total nitrogen. This was happening while the decomposition of the reserve minerals was releasing extra calcium to saturate the soil's exchange capacity more highly with this active, essential cation. This would favor the advent and the growth of a legume crop, like white clover, which fixes atmospheric nitrogen. But this clover growth would reduce the calcium saturation to the hindrance of its own future growth. It would put extra and active nitrogen into the soil. So while eliminating itself by exhaustion of the active calcium, it would favor the bluegrass by providing the active nitrogen.

The time period required for building up the sufficiently increased calcium saturation needed for the white clover suggests itself as the time interval between the "white clover years." That interval may well include "drought" years for whatever changes in the soil or cycle they bring about. Such are the theoretical suggestions for the number of inter-clover years on soils of the Kansan glaciation given loess deposits and located in the climatic setting of north Missouri. They are presented to be confirmed or refuted by further studies of soil fertility in relation to the periodic annual growths of white clover in our permanent pastures and lawns.

The Windmill Era

(*From page* 5)

and some have fallen from the towers, but one would go a long way to compile a series of farm accidents chargeable to the windmill in comparison to tractors, threshers, and corn shredders. Windmills represent man's oldest invention to improve on animal power. Fire, water, and wind were the daily companions of primitive people. Before the Christian era began, the Chinese and Japanese were using crude sail mills moving on a vertical shaft. The Persians were known to have had windmills of the vertical axis type in the seventh century. England is said to trace its windmill history to a Lancashire deed dated 1327. Today the oldest English windmill is located at Outwood in Surrey. According to the "Architectural Press" this mill which is still operating was built in 1665.

That famous man of all trades, Leonardo da Vinci, made sketches of the steps in constructing a windmill about the year 1500. Only shortly before, the first grain grinding mill was erected in Holland—that storied land where the windmill is a national emblem. Denmark also has been the scene of great windmill activity. Most of the mills there do not resemble the traditional ones of Holland. This is because Denmark had so little coal and convenient water power that chief reliance had to be placed in the velocity of the winds. Owing to special necessity for constant improvement and greater net economy in this source of power, Denmark set up one of the only wind power experiment stations in the world, in 1891 at Askov.

Fewer picturesque windmills were seen on my only tour of Holland than the sightseer has a right to expect. The broad flat meadows and green polders should have been dotted with them like raisins in a moist brown cake. Upon inquiry, we learned that the citizens are wide awake to the comparative dearth of those old post mills, with wooden or stone body and sails skimming on an inclined wind

shaft. They bemoan the steady decline of the old favorite trademark of Dutch thrift, which so often embellishes the native pottery and postcards. So they have organized the Hollandsche Molen, or the Society for the Preservation of Dutch Windmills. In this manner they have restored nearly 800 old country mills, besides erecting a statue at Rotterdam to the legendary lad with his finger jammed into the hole in the leaky dyke. By all means, they must preserve the things which stand ace-high in the anticipations of visitors from America.

Officials and leaders in antiquarian research along the Zuider Zee have at least halted the rate at which these rural windmills are vanishing. In 1953 the official count for the nation was about 1,140 of these mills, and this compares to the historical count of about 7,000 in the period between 1750 and 1800.

While the windmill has been used in Germany for centuries, it has never seemed to occupy the spotlight for the traveling public like those old mills of Holland. At the turn of the century, there were about 18,000 used by German farmers and millers. Only a few thousand remain. In place of the old type tower mill, several small plants and a few larger ones that generate electric power have been built in Germany.

IS there a place left for wind-driven generators to bring the conveniences of electric light and some limited power facilities to remote and isolated communities, both here and abroad? Their initial cost and the need for some storage of electric energy in batteries when the winds are not blowing have thus far tended to discourage wider application of natural force in that manner.

Numerous conferences have been held and countless papers prepared and read on this subject. Men interested in the utilization of the wind have been encouraged by the performance of experimental wind turbines of both large and moderate size and kilowatt capacity. It is all a highly complex engineering job, and the field is open for conjecture and trial. Fortunately, our best engineers like to tackle the toughest problems from many angles. Given a good basis for international cooperation and exchange of ideas and wind survey data, we should begin to hear from these folks before long.

From general conclusions reached by the engineers who have investigated and surveyed the various wind-electric schemes proposed, future developments seem to center on two economic ways of getting results. Medium-sized wind rotors that rate up to 100 KW could be used along with other forms of generating energy. These could be set up and prove a boon to faraway continental areas or on lonely but well-inhabited islands of the sea. Such spots have no local fuel supplies but usually enjoy a reliable average wind velocity. What makes such outfits seem economical is that they are substituted for or used as a supplement to much more expensive methods of generating electric energy.

A SECOND proposal is to have larger wind power machinery to generate energy, possibly rated up to 1,000 KW, and which have been already tested and used to some degree. These larger units would be built where winds are favorable. They would feed generated electricity into nearby networks. They would be auxiliary plants, and as such might save on cost of coal or oil, thus producing an extra backlog of energy. Others envisage wind plants as aids to water turbine power systems. If the water storage reservoir was large enough, the wind-driven plant might, they believe, be equal to an extra volume of rainfall, or sometimes justify an increase in water power facilities.

If and when practical obstacles are met, it is thought that wind turbines

can in time make a real contribution to total electric output. Many countries, including ours, have experimented with both small and large systems, but few of them have ever been heard from in a final way. This is simply because no way has been found to keep the cost of such wind plants at a point so that the cost of producing current may compare reasonably well with huge electric plants that use steam made from cheap coal. Yet interest does not seem to falter or die out. A few noteworthy reasons why this is still a popular field for further research may be added in conclusion.

DEMAND for more electric power is rising fast. In some areas there is a scarcity of fuels and hydro-electric opportunities. Costs at many existing water and steam plants are high and rising steadily. Many countries have been forced to rely on their own internal resources for making electric power, and they do not wish to bring in outside fuels. Besides, the coal and oil resources are dwindling in some regions and men are scanning the industrial horizon for new and better sources of power—atomic perhaps where not prohibitive.

With the great advances made in the airplane and the corresponding study of air currents and atmospheric phenomena, it is much easier now to design and operate successful wind-driven apparatus. Electric engineers have also found distinct advantages in the production of network power through various different sources of energy, instead of depending upon one source alone.

So it's not smart for us to write off the old windmill of our grandfathers and the ancients. In the hands of our amazing engineers and physicists, we may soon be provided with all kinds of power from moving air and still have lots of it left to transport ourselves and our freight above the clouds to distant places.

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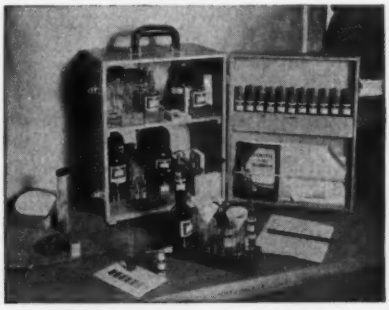

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For the Province of Ontario: Distribution Services, Ontario Agricultural College, Guelph, Ontario.

IMPORTANT

Requests should be made well in advance and should include information as to group before which the film is to be shown, date of exhibition (alternative dates if possible), and period of loan.

Request bookings from your nearest distributor.

AVAILABLE LITERATURE

The following literature on the use of fertilizers in profitable soil and crop management is available for distribution. We shall be glad to send these upon request and in reasonable amounts as long as our supply lasts.

Reprints

3-1-56 Potash in Agriculture
F-3-40 When Fertilizing, Consider Plant-food Content of Crops
S-5-40 What Is the Matter with Your Soil?
Y-5-43 Value & Limitations of Methods of Diagnosing Plant Nutrient Needs
A-1-44 What's in That Fertilizer Bag?
P-3-45 Balanced Fertility in the Orchard
Z-5-45 Alfalfa—The Aristocrat
ZZ-11-45 First Things First in Soil Fertility
T-4-46 Potash Losses on the Dairy Farm
Y-5-46 Learn Hunger Signs of Crops
TT-11-47 How Different Plant Nutrients Influence Plant Growth
AA-6-48 The Chemical Composition of Agricultural Potash Salts
GG-10-48 Starved Plants Show Their Hunger
SS-12-49 Fertilizing Vegetable Crops
BB-8-50 Trends in Soil Management of Peach Orchards
X-8-51 Orchard Fertilizaiton Ground and Foliage
KK-12-51 Potassium in Animal Nutrition
A-1-52 Research Points the Way to Higher Levels of Peanut Production
Y-10-52 The Nutrition of Muck Crops
CC-12-52 The Leaf Analysis Approach to Crop Nutrition
I-2-53 Sericea Is a Good Drought Crop
J-3-53 Balanced Nutrition Improves Winter Wheat Root Survival
K-3-53 Kudzu Keeps Growing During Droughts
N-4-53 Coastal Bermuda—A Triple-threat Grass on the Cattleman's Team
P-4-53 Learning How to Make Profits from Sweet Potatoes
T-5-53 Trefoil Is Different
DD-10-53 Sampling Soils for Chemical Tests
II-11-53 The Importance of Legumes in Dairy Pastures
JJ-11-53 Boron—Important to Crops
MM-12-53 White Birch Helps Restore Potash-Deficient Forest Soils
K-2-54 Soil and Plant Analysis Increase Fertilizer Efficiency
R-3-54 Soil Fertility (Basis for High Crop Production)
U-4-54 Nutrient Balance Affects Corn Yield and Stalk Strength
CC-6-54 Fertility Increases Efficiency of Soil Moisture
EE-8-54 Red Apples Require Balanced Nutrition
FF-8-54 Apply Fertilizers in Fall for Old Alfalfa, Grass Pasture and Timothy-Brome Fields
GG-8-54 Effect of Boron on Beets and Crops Which Follow
JJ-10-54 Principles Involved in Soil Testing
LL-10-54 Relation of Fertilizer to Quality and Yield of Flue-cured Tobacco
MM-10-54 Longer Life for Ladino
SS-11-54 Foliar Application of Plant Nutrients to Vegetable Crops
YY-12-54 Physical Condition of the Soil Affects Fertilizer Utilization
A-1-55 Potash-Deficiency Symptoms
C-1-55 Summary of Ten Years' Work with Complete Fertilizers on Sugar Cane
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G-2-55 Seven Steps to Good Cotton
H-2-55 Apparent Fertility Trends in Western Irrigated Soils
L-3-55 Soybean Production in the Southern States
P-3-55 N-P-K for Deciduous Fruit Trees
S-4-55 Greener Pastures Mean Better Living
U-4-55 Fertilizer Recommendations—Burley Tobacco
V-4-55 Planned Nutrition for Canning Tomatoes
W-5-55 The Production of Sugar Beets on Organic Soils
X-5-55 What Is Happening to Our Citrus Soils?
Y-5-55 Pasture Improvement Through Renovation
Z-5-55 Azalea Fertilization
EE-10-55 Fertilizing For Better Apples
HH-10-55 Fertilizers Will Cut Production Costs
LL-12-55 Potassium Deficiency of Alfalfa in California
A-1-56 Why More Alfalfa?
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C-1-56 A Successful Corn Crop on the Same Land Every Year Is a Possibility
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N-5-56 Fertilizer Placement for Corn in Minnesota
O-6-56 Plant Analysis As a Guide to Fertilization of Crops
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Q-8-56 Chemical Basis for Soil Testing
R-8-56 Nutrient Status Survey of Potatoes in Northwestern Washington
S-8-56 Pasture Improvement by Direct Fertilization

THE AMERICAN POTASH INSTITUTE

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"Well, Dick, my boy," said his uncle, "my congratulations! I hear you're engaged to one of the pretty Robins twins."

"Rather," replied Dick, heartily.

"But," said his uncle, "how on earth do you manage to tell them apart?"

"Oh," said the young man, "I don't try!"

* * *

"This is Possum Switch," the bus driver called out as he slowed down for a "four-corners" village.

Replied a wit from the back seat, "Are we in downtown Possum Switch?"

"Not now," retorted the bus driver, "we just was."

* * *

Mother: "Dear, didn't I tell you that you should say no if a sailor asks you for a kiss?"

Daughter: "But mother, they don't ask!"

* * *

A famous matador was fighting in the bull ring in a Mexican border town. Among the spectators was an old cowhand who was seeing his first bull fight.

The fight had reached the stage where the matador, armed with only a cape, was taunting the bull, avoiding the animal's horns by fractions of an inch and flipping the cape aside as the bull charged past.

At last the old cowhand could stand it no longer. He arose and shouted: "Buddy, he ain't never gonna run into that sack unless you hold it still!"

While discussing her wedding plans with a friend, the young lady said: "Bill is taking me to France on our honeymoon." "How nice," replied the friend, "how did you learn about it?" The engaged young lady smiled demurely "He said that after we were married, he would show me where he was wounded during the last war."

* * *

If the old-fashioned gal was so darned innocent, how did she know when to blush?

* * *

Sam was bringing the doctor back home with him to deliver his wife of their 14th child. As they turned into the barnyard, the doctor noticed a duck waddling up the driveway. "Is that your duck?" the doctor asked the expectant father.

"That ain't no duck," moaned Sam. "That's the stork with his legs wore off!"

* * *

"So you think you can support my daughter in the way she's accustomed to?"

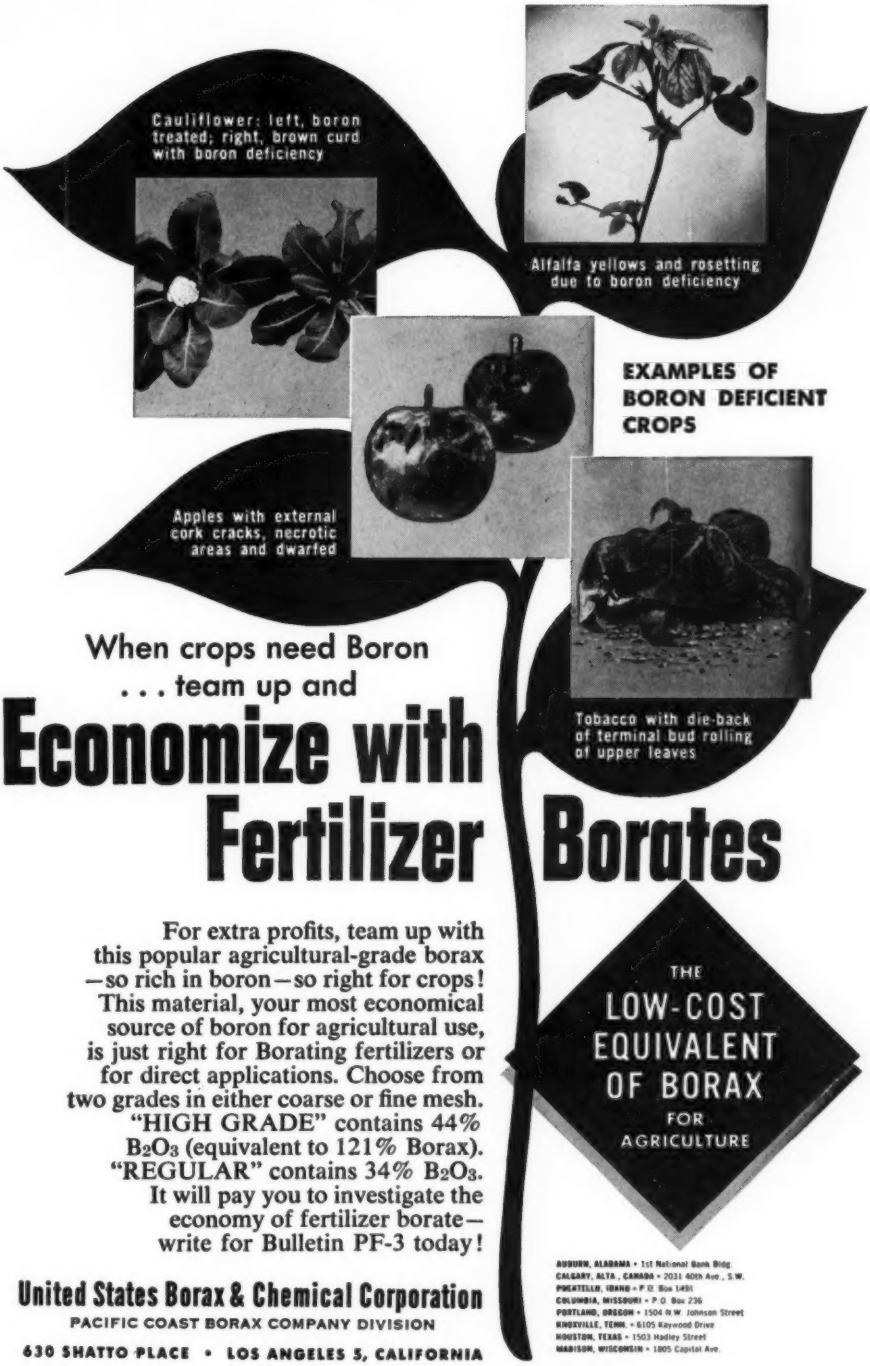
"No, sir, but I can accustom her to the way I support her."

* * *

A beautiful coed (from some other school) was wearing a blue sweater: it was one of those marvelous form-fitting kind.

Said she, coyly: "Don't you think it brings out the blue in my eyes?"

He: "Gulp."


Cauliflower: left, boron treated; right, brown curd with boron deficiency
Alfalfa yellows and rosetting due to boron deficiency
EXAMPLES OF BORON DEFICIENT CROPS
Apples with external cork cracks, necrotic areas and dwarfed
Tobacco with die-back of terminal bud rolling of upper leaves

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